A YEAR IN AGRICULTURE
NOLAN

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WITH

PLANS FOR HOME PROJECTS

BY

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FIG. 1. A FARM SCENE SUGGESTING SUCCESS

INTRODUCTION

Practical farmers often wonder what the schools can teach in the way of agriculture. Those of us who advocate agriculture as a school subject have been trying to answer this question for both the farmer and the educator. Some phases of the question are quite clear to progressive farmers as well as to teachers.

We do not propose to teach farmers how to "run their own business," but we do propose to teach both young and old farmers facts and principles which they can profitably use in their business.

It concerns us all, whatever our vocation and station in life may be, whether farming be done efficiently or not. It is no longer merely an individual matter as to whether Farmer X runs his own farm efficiently or not; it is a question also of public welfare. But the farmer in serving the larger interest also insures his private welfare.

It is an educational-economical proposition, that only those who *know* and *care* should be entrusted with the natural resources upon the wise use and conservation of which rest the prosperity and permanency of our nation. Many generations of farmers of the past have learned how to prosper and grow rich from the virgin resources of the land. They learned and practiced the art of farming for these purposes

and passed this knowledge down from father to son; but they knew little of the science of agriculture or of the sciences upon which agriculture is based.

Young men and women can learn in schools how to improve and conserve the fertility of the soil; how to improve the economic plants so that they may be better adapted to their surroundings and have better yielding qualities; how to improve farm animals so that there may be greater production and better quality of products; how to combat insect pests and diseases; how to bring about a more productive, profitable, and permanent agriculture; and how to organize a more satisfying country life. These are the demands of modern agriculture.

The farmer should be lord of the three kingdoms over which he rules. The plants, the animals, and the minerals are his domain; his farm is made up of these three kingdoms. How unfortunate for all if he does not know the plants, animals and minerals with which he deals. What would we think of a physician who did not know the science of physiology or chemistry? What could the lawyer hope to do who did not know the laws of his state, or the principles underlying legal practice?

The young farmers who are now studying scientific agriculture know that they must be masters of the kingdoms with which they deal: they must know plants, animals and minerals; how to produce, protect, and improve in the best and most economical way their plants and animals; and how to conserve and use most wisely the mineral resources of their farms.

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A YEAR IN AGRICULTURE

PART I

AGRONOMY

CHAPTER I

HOW PLANTS GROW

The chief concern of the farmer is the growing of plants. It is for the plants that he improves the fertility of his soils. It is the plants upon which he feeds his animals. It is the plants, directly or indirectly, that he sells for money or eats as food. It is for the protection of plants that he combats the insects and diseases; and for the cultivation and harvesting of plants that he purchases and uses farm machinery.

Our study of agriculture will therefore begin with plants, and as we proceed we shall learn the latest and best known methods of the production and use of the economic plants of our section of the country.

Human interest in plants. Whether he knows it or not, everyone has a vital interest in plant life. The life of man and animal depends almost entirely on plants or plant products. From the fruit on our table to the clothing we wear,

the houses we live in, the vehicles we ride in, and the art we enjoy, the plant interest is an important factor. Most of the world's great industries are carried on with raw material derived from plants. The farmer, the gardener, the lumberman, the carpenter, the shipbuilder, the cotton manufacturer, the sail-maker, and even the miner, all depend upon the products of the plant life that is or was on the earth or in the sea. The air which we breathe is purified partly through the processes by which the green plants live. Human life could not continue long without the aid of substances produced by the life and growth of plants.

How plants grow. Let us begin at the beginning of a typical plant growth and trace the steps and processes in its development. If we start with the seed of a higher plant for our study, we have not begun at the beginning, for this was made back in the blossom when the seed was forming. The seed of the plant consists of a tiny plant imbedded in a cotyledon, the bulky portion of the seed, resting in its development until favorable surroundings start it again in growth.

A good seed is, of course, alive and healthy. It is true to the parents which produced it. It is large and plump, showing that it has a maximum amount of food supply. In quantity it is clean and free from foreign matter. When this seed is placed in medium temperature, with sufficient moisture and plenty of air, it will begin to grow, to *germinate*. This favorable surrounding for most seeds is made in the soil of the seed-bed. By *germination* we mean that the moisture absorbed into the cotyledons begins to dissolve the starchy

material, which can then be used for the growth of the young root and leaves in the plant. The tiny roots push out into the soil, root-hairs establish connections with the soil particles, and the roots begin to absorb the mineral plant-foods in solution.

The shoot breaks through the surface of the soil, unrolls the leaves, and the sunlight helps to change the materials of the soil so that they can be assimilated into the parts of the growing plant. In the presence of sunlight, and under the life principle in the growing plant, the carbon dioxide of the air enters the breathing pores of the leaf, and combines with the water taken up by the roots to form the sugar and starch substances in the leaves. The excess of water needed to bring up the minerals is thrown off from the leaves by *transpiration,* and the excess of oxygen taken in to supply the carbon in the carbon dioxide gas is also given off through the leaves as free oxygen. The starch material thus made in the presence of and by the help of the green particles in the leaf and the sunlight is then changed to sugar and is carried by the cells downward and outward to the various tissues of the growing plant to be assimilated into root, stem, leaf, and later into flower and fruit. This process continues until the plant has reached its full maturity.

It will be of interest to note that considerable work is done in causing a plant to grow. In the corn plant, for instance, for every pound of dry matter produced, 350 pounds of water must pass through the leaves and be transpired into the air. It has been determined that this represents an energy in an acre of corn producing fifty bushels equivalent to 375 horses

working 16 hours a day for 120 days. All this energy, however, is not lost, because the carbon stored in the grain and body of the plant, when burned or eaten by man or beast, is transformed again into energy, heat, and life processes.

Before the plant whose history we are tracing is finally mature, steps are taken to reproduce the species before it dies. Somewhere upon the plant special adaptations are made for the development of the reproductive cells. These adaptations constitute the flowers. Two kinds of cells are produced. They may be in the same flower or in different flowers. The female or egg cell is formed as the foundation of the seed in the pistil of the flower in which the future embryo is to develop. The male cell is formed as a pollen grain in the stamen of the flower. Before the embryo plant will develop and the seed mature, there must be a union of the male and female cells of the plant. The agencies for bringing these two cells together vary widely. Among the plants, gravity, winds, and insects are the common agencies. When the pollen cell and the egg cell unite, then the embryo plant begins to form. The little leaves, the short stem on which the roots develop, the cotyledons containing the plant-food for the developing embryo mature, and the seed enters a dormant or resting period, awaiting the time when under favorable conditions it may begin the growth as mentioned at the beginning of this discussion.

CHAPTER II

WHEAT

As source of world's food supply. Wheat bread would sustain life better than any other one article of food in the world. The average amount of wheat eaten by each person in the United States is five bushels a year. This is equivalent to a barrel of flour, or about two hundred and fifty loaves of bread. Fortunately, wheat is grown in almost every part of the temperate zones.

Varieties. Wheat, the source of the world's most important food, is a grass. Man gets much of his food from the grasses of the field. There are eight principal species of cultivated wheat: einkorn, spelt, emmer, durum, poulard, Polish, club, and common wheat. There are two hundred and forty-five leading varieties of wheat. Wheat is classified into hard and soft varieties, depending upon the relative degree of hardness of the ripe grain; and into spring and winter wheats according to whether they will mature when sown in the spring or in the autumn preceding harvest.

In the selection of varieties, the most important considerations are winter hardiness, stiffness of straw, high yielding and disease resisting powers, and good milling qualities. Among the best yielding varieties recommended for general use in the North Central States are Rudy, Farmer's

FIG. 2. A GROUP OF EXPERIMENTAL PLOTS

Friend, Mealy, Gold Coin, Winter King, Michigan Amber, Red Wave, Grains o' Gold, Tennessee Fultz, Blue Stem, and Turkey Red.

Places of wheat in the rotation. Wheat should never be grown on the same land continuously. Some kind of crop rotation must be practiced in order to get the best results. What the other crops should be and how many different ones should be included in the rotation, will depend upon a number of factors. One thing, however, is well established; that is, that some kind of a legume, usually clover, should have a place in the rotation. In a system of grain farming, the following rotations are good:

1. Wheat	1. Corn
2. Corn	2. Oats
3. Oats	3. Wheat
4. Clover	4. Clover

Sell only the grain, or better, feed it to the stock on the farm, and return all the rest to the soil, using limestone and rock phosphate as mineral foods where needed.

Many state experiment stations have shown beyond question that rotation of crops has brought higher yields of wheat than annual cropping. It must be said here, however, that crop rotation alone, even though a legume be included in the system, will not maintain permanent soil fertility. That, however, is another question, and will be taken up again under soils.

Preparing the soil. Preparation of wheat ground will depend upon the nature of the soil and upon the previous crop. Some farmers sow wheat in standing corn in Septem-

ber. The thorough cultivation of the corn crop has prepared the soil for the wheat. A much better practice consists in cutting off the corn and thoroughly disking and harrowing the ground before drilling the wheat. When wheat follows oats, the ground should be carefully plowed and harrowed as soon as possible after harvesting the oats. Wheat likes a firm sub-surface and a fine "onion tilth" for a seed-bed. When wheat follows clover, the plowing may be delayed to get the advantage of some second growth clover to plow under, but this must be done early enough to allow the seed-bed to settle before sowing the wheat.

Seed time. The best time to sow winter wheat in the central states varies from the second week in September to the first week in October. On fertile, well-prepared soil, seeding may safely be done later than where conditions are less favorable.

On account of the danger of trouble with the Hessian fly, it is advisable to delay seeding as late as possible. Late sown wheat often escapes infestation from the fly, and will often be just as far ahead when winter comes on as the earlier sown wheat. For spring wheat the land may either be plowed in the fall or early in the spring. The preparation of the seed-bed from fall or spring plowed land does not differ from the practices already described.

Methods of sowing. Wheat does better when sown with a drill. From experiments in drilling and broadcasting the results have invariably been in favor of drilling, especially with winter wheat. Drilling requires less seed for a full uniform stand, and insures better germination. Drilled wheat

will stand the winter better than that which is sown broadcast. If the ground is trashy, a disk drill will do the best work, but on clean, well-prepared ground, any good seed drill is efficient. Seed wheat should be run through the fanning mill to remove the weed seeds, dirt, chaff, and damaged kernels.

Rate of seeding. With medium-sized seed of good quality, on a well-prepared and fertile soil, from four to six pecks per acre will usually be sufficient for sowing. Every farmer must determine for himself, according to the conditions of his own land, how much seed should be used. Winter wheat is not sown as thickly as spring wheat. The rate is less on poor soils than on rich soils.

Seed selection. The selection of good seed is a factor in wheat production which should receive the careful attention of every farmer. As a means of increasing his wheat yield, the farmer can well afford to select his seed out of the best portion of his crop, to use the fan mill, and to grade it in such a way as to get the largest and plumpest seed for sowing.

From careful tests in many experiments, it has been shown that large and plump seeds have yielded from one to five bushels more per acre than the smaller and lighter seeds. It pays, therefore, to take the trouble to grade seeds so as to get the largest and heaviest seeds for sowing. A good fanning mill is the simplest and most practical means of grading seed on the farm, and every farmer who grows small grain to any considerable extent should have one.

Any variety of wheat can be improved and kept from "run-

ning out'' by careful seed selection and good soil treatment.

Management of wheat after harvesting. Much loss in the value of the wheat crop results every year due to exposure in the shock before threshing. When wheat stands in the shock for several weeks exposed to the weather, the grain loses its brightness and the bran becomes brittle, so that when milled the bran crumbles into the flour, producing inferior grades. Fermentation and sprouting may also occur in the shock and cause serious injury. Whenever wheat cannot be threshed as soon as it is dry enough, it is advisable to stack it, for the market value of the grain at threshing time will often be enough higher to pay for the extra trouble.

Wheat diseases. The wheat crop is subject to the ravages of several diseases. There are two more or less common diseases reducing the yield of wheat. First, *smut* is a parasite which destroys the kernels in the head, and substitutes its own reproductive parts or spores in place of them. In the second place, parasites, such as *scales, rusts,* etc., attack the stalk or leaves of the plant, absorbing the nourishment and dwarfing the kernels. Scientists have not yet succeeded in working out methods which will control or prevent all the diseases to which the wheat plant is subject. Experiment stations all emphasize the importance of treating seed wheat with formaldehyde as a disinfectant. This will prevent the ''stinking smut,'' and greatly reduce other diseases.

Insect enemies of wheat. The loss of wheat each year from insect pests is very great. The Hessian fly, the jointworm, and the wheat-stem maggot are three insects taking heaviest toll from our fields.

The Hessian fly. The adult insect is a small, almost black, two-winged fly, resembling the mosquito, and of about the same size. As a rule the flies remain close to the ground, and in the fall, when they are most abundant, they may be

FIG. 3. LIFE HISTORY OF THE HESSIAN FLY

seen depositing their little pink eggs in the grooves of the upper surface of the leaves. The eggs hatch into the larvae, which change from a pinkish to a greenish-white tinge when full grown. The larva goes into the pupa or "flaxseed" stage, a period of resting in which the larva is encased in a

brownish leathery covering resembling a flaxseed. This is found at the base of the plant in the fall.

There are two generations of the fly during the year, one in the spring and one in the fall. The adults issue from the flaxseed on the stubble in September and deposit their eggs on the young plant. The larvae hatch and work their way down into the leaf sheath, where they change to the flaxseed stage and remain over winter. The infested plant has no central shoot, is leafy and stocky, and is likely to die out in the winter. The spring generation of the fly attacks the stem near the joints, weakens the stem, and causes the plant to fall before the harvest.

Proper fertilization and culture may assist the plant to resist the attack of the fly, and late sowing may avoid infestation.

The joint-worm. The adult of this worm is a small, black, four-winged insect resembling a winged ant. The grub is white and about an eighth inch long. The entire life history of this pest is spent within the stem of the wheat. In the spring the larva changes to the pupa, and this soon changes to the adult, which gnaws a hole in the stem and emerges. The stem is often warty and knotty at the joints, causing it to bend or break. Upon opening one of these joints a small grub will be found. There is no remedy once a field becomes badly infested with joint-worm. The plants can be strengthened and helped to resist the attack only by maintaining soil fertility and good cultural methods.

Keeping up the fertility of the soil so that plants may be properly fed, good systems of crop rotation, and clean culti-

vation will contribute much to the success of the farmer in his effort to combat insect pests and plant diseases.

Notebook Questions

1. Why is wheat a more popular cereal for bread than corn?

2. How does wheat rank in production of bushels with the other leading farm crops in this country? What is the leading wheat country of the world? Which states of this country lead in wheat production?

3. What is the average yield per acre in your state? What yields have good farmers and state experiment stations obtained?

4. What does it cost to produce an acre of wheat in your locality? What is the current price of wheat on the market?

5. What good qualities should be sought in choosing a variety of wheat to sow?

6. What is the value of grading seed? How is it most simply done?

7. What is the place of wheat in a good system of crop rotation?

8. What fertilizers are needed in most soils to insure a larger crop of wheat?

9. What are the best methods of combating diseases and insect pests of wheat?

10. What is meant by "bonanza" wheat farming? Where is it practiced? What is the future of this method?

11. What is the value of covering winter wheat with straw?

12. Since we can open up little more land to cultivation, and the population of our country is increasing at the rate of twenty-five per cent each decade, how is the bread supply of the future to be obtained?

Practical Exercises and Home Projects

1. **The wheat grain.** Examine grains of wheat that have been soaked a few hours in water. The use of a hand lens will assist in this examination.

On one side of the grain note the deep furrow or *crease.* On the opposite side at the bottom there is a small, rough, circular spot called the *embryo* or *germ.* Within it are folded the first root and leaves of the young wheat plant. The top part of the grain is covered with tiny hairs which together are called the *brush.* The *base* is the opposite end of the grain.

Cut one grain lengthwise with the *crease* and the other across it. Note the color of the interior. Flour is made from the interior portion of the grain. The grain is surrounded by a hull which furnishes the bran. How many coats can you find in this hull covering the grain? About seventy-five per cent of the grain is made into flour, the rest is *bran* and *shorts* or *middlings.*

Draw cross and longitudinal sections of the wheat grain. Draw also a whole grain, labeling the parts observed as directed above. Keep a neat notebook record of all observations, facts noted, and drawings made.

2. **The head of wheat.** If possible at this season, provide each student with a few heads of wheat. Let each student examine the head of wheat closely, verifying the statements and answering the questions below:

The head of wheat is a *spike.* The central stem of the spike is called the *rachis.* The *rachis* is notched on two sides and from each of these notches there grows a very short stem or *spikelet,* that has attached to it several bunches of small husks containing seeds. How many grains to the spikelet? There are two chaffy parts around each spikelet, called *outer glumes.* Each kernel in the spikelet is enclosed on the out-

side by a *flowering glume;* inside of this is the *palea.* There may be one or more sterile flowers in the spikelet which did not develop into kernels of wheat.

FIG. 4. KERNEL OF WHEAT

Remove all the spikelets from a head of wheat. Draw the *rachis.* Draw a grain with its chaffy parts opened, and label the *palea,* the *grain,* the *flowering glume,* and the outer *glume.*

Count the grains in one spike of wheat. Find average of all grains counted in the different heads by the class. Are there any empty glumes in your spike of wheat? What may have caused empty glumes?

3. **Wheat samples report.** Provide each student with 100 grains of wheat as a sample. Copy the following report card in your notebook, and fill out properly from your observation of the sample of wheat given:

REPORT CARD

WHEAT

Name ....

No. Sample ....

Variety ....

Color	Whitish	per cent
	Red	per cent
Hardness	Hard and vitreous	per cent
	Soft and starchy	per cent
Size of Grain	Large	per cent
	Small	per cent
Unsound grain		per cent
Foreign matter		per cent
Weight of 100 grains		grams

Remarks ....
....
....
....

EXPLANATION OF POINTS

Color. Whitish wheat is of a clear, somewhat yellowish color. Red may be from dull to clear.

Hardness. Hard shows little or no starchy portion. Soft shows nothing but starch.

Size. Large size grains include those measuring ¼ inch or more in length and with a proportional width and thickness.

4. **The wheat plant.** Go to the wheat field or to some place where volunteer wheat is growing, select a well-developed wheat plant, loosen the soil about its roots, and remove it with as many of its roots attached as possible. Wash the soil from the roots as thoroughly as possible and take to the laboratory for study. Each pupil (or each two) should be provided with a plant, and should examine and report upon all points as follows:

What kinds of roots has the wheat plant? Note the enlarged place where the roots and stalk meet; this place is called the *stool.* The characteristic of the wheat to spread out over a small area and take root is called *tillering* or *stooling.* How many stems has your plant? The stems are called *culms.* How many leaves on your plant? Where do they start? Carefully tear a leaf from the *culm,* and notice how the lower

part of the leaf surrounds the *culm*. This part is called the *sheath,* and the loose part of the leaf is the *leaf blade.* The faint ring from which the leaves start is the *node.* Count the nodes. The space between the nodes is the *internode.* Note the length of the internodes. Split the culm and examine the inside.

CHAPTER III

OATS

Items of general interest. Oats, as a farm crop, have come into such prominence with the development of the central and northern portions of this country that now they are one of the important cereals of these sections. Like other cereals, the oat is an annual grass, with jointed stem and fibrous roots system. One seed usually produces from three to seven stems having a height which varies from two to five feet. The flower of oats is in the form of a panicle, consisting of a central stem from which numerous branches are given off, bearing the spikelets of flowers. The developed kernel remains tightly enclosed within the *flowering glume* and *palea*.

Types of oats. Oats may be divided, according to the appearance of the panicle, into two classes; *spreading* or *closed*. Oats may be classified into spring or winter varieties. They may also be divided into early, medium, and late varieties, based upon the time of ripening. Sixty-days is a well known early variety, while Siberian, Swedish Select, and American Banner are common, medium, and late varieties. On the market, oats are classed according to color of the grain; as white, black, and mixed oats.

Adaptation. Oats are best adapted to a cool, moist cli-

mate, and therefore do best in northern sections of the country. Oats have a wide adaptation to soils, and fair yields may be secured on almost all types of soils in cool, moist climates. Oats draw heavily upon the moisture and fertility of the soil.

Place in the rotation. Oats usually follow corn in the rotation in the corn belt states. Common four-year rotations are: *corn, wheat, oats,* and *clover; corn, oats, clover,* and *wheat;* or *corn, corn, oats,* and *clover.* When the farmer desires to get a stand of clover or alfalfa under oats, the best results are obtained by using an early variety of oats.

Preparation of seed-bed. Oats, being hardy plants, require less preparation of the ground for seeding than most other grain crops. In many places oats are seeded on the corn ground without any previous preparation. Sometimes they are sown broadcast and covered with a disk or spike-tooth harrow. They are often sown with a disk drill, in which case a more uniform stand is secured and usually a larger yield is obtained.

Time and rate of seeding. Best results are usually obtained from early sowing. The best time to sow oats is as soon as the soil is dry enough in the spring to get on to it with horses and implements. Seed oats should be run through a fanning mill to remove small kernels, sticks, trash, and weed seeds. The rate of seeding varies from six to ten or more pecks per acre, the common rate being about eight pecks per acre.

Harvesting. Oats are harvested by methods similar to those of wheat. When the heads have turned yellow and the grains have reached the hard dough stage they should be cut. In order that the oats may dry thoroughly the bun-

dles are set up in shocks of ten to twelve bundles each. Thrash from the shock as soon as they have dried out, or from the stack as in the case of wheat.

Uses of oats. The greater part of the oat crop is used for feeding live stock. They are relatively high in protein, the muscle-building material, and are therefore valuable for young animals, and for feeding horses at heavy work. Oats have long been used as a human food, in the form of oatmeal or ground oats. Oats straw is very valuable for feeding live stock. It is frequently used as roughage for keeping stock over winter. It is also valuable for bedding. Oats may also be used to supply quick temporary pastures for all kinds of live stock.

Smut of oats. The most destructive disease that attacks the oats is the loose smut. It may be recognized in the field by the black powdery spores that attack the heads and prevent the grain and the glumes from developing. The covered smut is a similar disease, affecting only the kernels of the oats, which are displaced by black spore masses. Methods for controlling these smuts are described in the practical exercises and home projects of this chapter.

Notebook Questions

1. How does the value of the oats crop in your community compare with that of other grain crops?
2. What are the common returns per acre for oats in your community? What should reasonably be expected under improved conditions of soil, seed, etc.?
3. Why are oats seeded as early as possible in the spring?

4. List a number of uses that oats serve.
5. Name the common varieties of oats.
6. How is oats smut successfully controlled?
7. What is the current price of oats on the market?
8. What is the legal weight per bushel of oats?
9. What are the leading oat-producing countries of the world?

Practical Exercises and Home Projects

1. **Study of the oat plant.**

(a) Each student should be provided with a specimen of the mature oat plant including stalks, leaves, and panicles.

(b) Explanation of terms:

Panicle—The complete "head" of oats.

Rachis—The straight stem forming the axis of the panicle.

Spikelets—Branches from the rachis, bearing the grains.

Glumes, palea, etc.—Same as in wheat.

(c) Make a sketch of an oat head, showing all these parts. Label each part of the drawing.

(d) Note the following points, and make notations in your notebook:

1. Number of grains to a spikelet. Number of infertile flowers.
2. Number of glumes to a grain.
3. How do flowering glumes and outer glumes differ from those in wheat?
4. Compare wheat and oats in amount of *stooling* and in amount of *leaf surface*.

2. **Problems for oat panicles.**

(a) Each student should have a well filled panicle of oats for this problem.

1. Number of grains in the panicle.......... ....
2. Total weight of grains.................... ....
3. Number grains per pound................. ....
4. Number panicles to make a bushel......... ....
5. Number panicles per acre to make 100 bushels............................... ....
6. Number panicles per square foot to make 100 bushels per acre.................... ....

3. **Examination of sample of oats for seed.**

(a) Count out 100 grains of oats for this exercise.

(b) Examine the oats and fill out the following table:

Color	Yellowish	....%
	Reddish	....%
Size	Large	....%
	Small	....%
Unsound grain and foreign matter.....		....%
Weight of 100 grains..................		.... grams
Number grains per pound..............		....
Number sown per square foot, 2 bushels per acre		....
Number grains in 5 grams..............		....
Per cent of hulls......................		....%

4. **Treating oats for smut.** This exercise may be made a demonstration at the school or some nearby farm home, or it may be carried on as a home project.

Take a pound of formalin (formaldehyde, 40 per cent) and dissolve it in 50 gallons of water. Spread the grain out on a clean floor and wet it thoroughly with the solution, using about a gallon for each bushel of the grain. The work can be easily and thoroughly done if one person shovels the oats over while another applies the solution with a sprinkling can. Then stack the grain up in a pile, cover it over with carpets or blankets to retain the fumes of the formalin, and

allow it to remain two or three hours, or even over night. Spread the grain out to dry before seeding. It should not be returned to the same bags, unless they are treated with the solution.

Describe in detail in your notebook the method used in this project.

CHAPTER IV

CLOVER

The Queen of King Corn. Dr. Cyril G. Hopkins of the University of Illinois has written a little circular which he calls "The Story of a King and Queen." Corn is the king, and clover the queen. In this circular Dr. Hopkins says:

"Young King Corn found an ideal home for himself on the dark prairie soil, and for many years he lived as a very independent bachelor; but there finally came a time when the supply of food which he had found already prepared in the soil became partially exhausted, and in hunger he said to himself, 'It is not good for man to be alone.' He then sought a princess named 'Clover,' and thereafter always rejoiced that she consented to be his Queen. Where she prepared the soil, King Corn was again as well fed as ever.

"Years passed, and they were happy and prosperous years; but finally both corn and clover were forced to remember the ancient saying, 'And this too shall pass away.' King Corn began to complain again that his bed was getting hard and the food furnished him was not sufficient. Queen Clover replied that she, too, was suffering from hunger, and that her home in the soil which had always been sweet and clean was becoming sour."

Thus the story continues, telling the relations of clover to soil and crops.

Red clover. This "Red Plumed Knight," as it is frequently called by its admirers, is a native of Persia. Clover is more generally grown as a forage crop than any other legume; it is adapted to a wide variety of soils and climates; it is rich in nitrogen and furnishes a large amount of organic matter for green manure; it is nutritious, palatable, and valuable as a feeding substance; and it occupies an important place in crop rotation. It is a perennial, and, like most other clovers, does best on deep, rich loam that is well drained.

FIG. 5. THE CLOVER PLANT

Soil preparation. When the soil is in the best possible tilth, the clover "catch" is surer. Lime in considerable quantities must be present in the soil, and other mineral plant-foods, such as phosphorus and potassium, are necessary elements in the growth of clover. In order to establish a permanent and healthful soil for corn as well as for clover, about one-half ton per acre of pure steamed bone-meal, or a ton of fine-ground rock phosphate and two tons per acre of ground limestone, where needed, should be applied once every four or five years. Although clover has the power of procuring most of its nitrogen supply from the air, through the

bacteria on the roots, yet land rich in nitrogen grows the better clover crop. Liberal applications of barnyard manure as a top-dressing generally give good returns.

Seeding. Clover seed may be sown broadcast in February, March or April on land seeded the previous fall to wheat or rye; or it may be seeded in the spring with oats or barley. From eight to twelve pounds of seed per acre is sown, if the seed is of good quality and the soil in good condition; otherwise the quantity should be increased. Sometimes red clover is sown in August or September, where the soil is in condition to allow a good "catch" before the winter.

Clover in crop rotation. We can scarcely think of any good system of crop rotation without the use of clover or some other legume. For three-year rotations, such systems as corn, oats, and clover, or corn, wheat, and clover, are used. Four-year rotations (in grain farming) include wheat, corn, oats, and clover; or corn, corn, oats, and clover (in live-stock farming). In the four-year rotation for grain farming a "catch" crop of clover may be seeded on the wheat ground and plowed under the next spring for corn, and the regular clover crop in the fourth year may be mowed once or twice and left lying on the land, the seed crop afterwards being harvested with a buncher attached to the mower.

"In grain farming, only grain or seed should be sold from the farm; all clover, straw, and stalks being returned to the land in order to maintain the supply of organic matter and nitrogen, which are just as important as limestone and phosphorus; and in live-stock farming, all produce should be used for feed and bedding and all manure carefully saved and

returned to the land, preferably within a day or two after it is produced, in order to prevent the waste of plant-food." —*Illinois Experiment Station, Circular 145.*

Manural value of clover. A clover crop turned under furnishes fresh organic matter which decomposes rapidly, improving the physical condition of the soil, giving up available nitrogen for the plant's use, and liberating mineral plant-foods of the soil, otherwise unavailable as plant-food.

One ton of clover hay contains as much nitrogen as four tons of stable manure, and, in addition, five pounds of phosphorus, thirty pounds of potassium, eight pounds of magnesium, and about thirty pounds of calcium. There is about the same amount of nitrogen in the roots and stubble of clover as the clover obtained from the soil, so that removing the clover crop does not add any new supply of nitrogen to the soil. In systems of permanent soil fertility, clover must be used in the rotation, and either fed to live stock with the manure returned to the soil, or all of the crop but the seed turned under to supply the nitrogen and organic matter necessary for the maximum production of farm crops.

As to whether one should turn under all the clover growth, either as manure or mulch, depends upon how much of the nitrogen it contains is needed to balance the phosphorus in the soil. If the second crop of clover is sufficient to balance the phosphorus, the first clover crop may be removed and the seed taken from the second crop and the straw returned to the land. Where the soil needs both crops, the first crop may be clipped and left on the ground and a buncher used to cut the seed from the second crop. The whole growth with

the first clipped crop is then turned under as a green manure.

Red clover as hay. Next to alfalfa, red clover is one of the most valuable forage crops for dairy feeding. In fact, red clover is a good feed for almost every farm animal. It furnishes a protein content to stock feed, giving a better balanced ration than timothy hay. Clover is also a good soiling crop, and should supply from eight to ten tons per acre for this purpose. Clover should be cut when free from moisture, raked into windrows, then allowed to cure in haycocks. The chief value of clover, like alfalfa, is contained in the leaves, and if the leaves dry in the swath and break off in handling much of the value is lost.

If the crop gets wet while curing, the color, rich odor, and much of the palatability are lost.

Red clover furnishes excellent pasture for stock of all kinds, but excessive pasturing results in the destruction of the plant.

Clover seed. As was stated above, the seed is usually harvested from the second crop. The largest yields of seed are usually obtained when the first crop is cut early, because in this case the seed of the second crop will form earlier and possibly escape the second brood of clover seed midge, and other clover seed insects. It is a well known fact that bumblebees, as they feed upon the clover blossom, pollenate the flowers and thus make possible fertile clover seed. For this reason, more than any other oftentimes, the first crop of clover is not a profitable seed crop, since bumblebees are not so abundant in the early summer.

Clover should be cut for seed when the heads have turned

brown and the seeds are in the dough stage. The average yield is about two bushels per acre, but by controlling the insects the yield should be nearly doubled.

Notebook Questions

1. Why is Dr. Hopkin's "The Story of a King and Queen" so well applied to corn and clover?
2. Describe the clover plants as to the nature of the roots, stems, leaves, and flowers.
3. What and how much plant-food does a ton of clover hay require?
4. Describe a crop rotation system where clover enters as one crop.
5. Where is clover seed sown? How much seed is required per acre? What is the current price of the seed? How may we increase the production and yield of clover seed?
6. When is clover hay usually cut? Describe the methods of harvesting and handling the hay.
7. Explain the value of clover as a green manure crop.
8. Try to show whether it is more profitable to turn under the clover crop or to cut it as hay in a system of permanent soil fertility.

Practical Exercises and Home Projects

1. **The clover plant.** Dig up a clover plant, get as many roots as possible, wash them clean, and bring the whole plant to the laboratory for study.

Observe and note the following points:

(a) Number and length of stems from the common root. Are stems erect, spreading, or twining?

(b) Are there any branches?

(c) Kind, number, and length of roots. Look for the nodules on the roots. These contain the bacteria which have the power of obtaining the free nitrogen from the soil air and storing it in the plant.

(d) Kind, shape, and arrangement of the leaves. Sketch a leaf.

(e) If the clover is in bloom, notice the location, form, and color of the blossom.

(f) If in seed, note kind, number, and shape of seed pods. Note the number of seeds in a pod. Draw a seed pod and an enlarged single seed.

(g) Draw the whole plant in your notebook, showing roots, stems, leaves, and flowers.

2. **Examining and testing clover seed for purity and germination.** Clover seed frequently shows a weed content of from one to seven per cent, and a germination as low as forty per cent. It is, therefore, highly important that we have pure seed of high germination.

(a) Count out 100 seeds from a sample given. Separate the seeds into three lots—*good clover seed, weed seeds,* and *foreign matter.* What percentage is good seed? How much would a farmer pay for a bushel of good seed at the rate per bushel of the seed examined?

(b) Place 100 seeds on moist blotting paper laid in a shallow place. Lay a moist filter paper over the seeds, invert a second plate over the first, and set away for twenty-four hours.

Examine and record the percentage of viable seeds.

(The Crop Improvement Committee, 64 Board of Trade, Chicago, has an excellent blotter for small seed testing.)

3. **Examination of clover seed insects.** There are three insects that must be guarded against in the raising of a good crop of clover seed: the seed midge, the seed chalcid, and the seed caterpillar. The female lays her eggs in the green

flower heads the latter part of May. The newly hatched larvae feed upon the young clover seed.

Pupils should gather specimens of the larvae of the clover seed midge for examination. If the study is made in the summer, collect clover heads partly green and partly in bloom, and place in tight glass jars. The larvae present will emerge, and may be seen and counted. In autumn larvae of various sizes may be found in dead clover heads, before they go to the ground to winter. Collect and examine a number of clover heads for the seed insects.

Clover cut about the middle of June results in the killing of the undeveloped larvae and the saving of the seed crop.

A clover head half red and half green usually indicates that the seed midge is present.

CHAPTER V

ALFALFA

The plant. Alfalfa is an ideal forage plant. It belongs to the legume family, to which cow-peas, soy beans, and red clover belong. It was grown in southwestern Asia many centuries ago and came to California by way of South America at a very early date. Later it was successfully grown in Kansas, and since we have learned its requirements it is now being grown in every state of the Union.

Why should the farmer who has forty acres of land buy the forty adjacent acres, when he can utilize the forty lying beneath and the forty lying above his present holdings by growing alfalfa? When we remember that the alfalfa root reaches down and draws much of its food from lower levels untouched, and that it utilizes large quantities of nitrogen occupying so fully the air above, than we can see that this reference to the forty below and the forty above is not altogether a myth. Since millions of dollars' worth of nitrogen is present over every acre of land, the farmer who grows alfalfa is literally a millionaire. His millions are in the air.

Alfalfa is a perennial plant with purple flowers. The numerous stems which are produced arise from a crown; they grow from fifteen to twenty-four inches long, and are erect or spreading. The long taproot penetrates to a great depth,

with many small secondary roots. There are three leaflets to each leaf, the third leaflet having a short stalk of its own, instead of growing from the same point, as in the case of red clover. The seed pods are in coils, brown when ripe, and contain several seeds. The seeds are somewhat kidney shaped and about the same size as red clover seeds.

Values of alfalfa. There are three great values of alfalfa as a farm crop:

First, it is one of the most profitable crops, commercially, that the farmer can grow. When he is able to cut from three to five tons of alfalfa hay per acre during one season, and sell this hay at from $15 to $20 per ton, he begins to realize the money value of alfalfa. It is not at all uncommon for a farmer to clear from $50 to $60 an acre on his alfalfa crop.

Second, it is one of the most valuable live-stock feeds grown on the farm. Alfalfa is rich in protein, and thus helps to balance the ration in feeding corn, ensilage, or timothy hay. Alfalfa has been found to be the best general feed for dairy cows, beef cattle, sheep, and even for swine and poultry, in the production of what is most desired in these animals.

Third, it fits into systems of crop rotation planned to maintain permanent soil fertility. Alfalfa being a legume, serves, as does the clover, to draw free nitrogen from the air to enrich the soil. The long, deep root system of the alfalfa enables it to feed below common soil levels, bringing to the surface soil increasing portions of organic matter and plant-food to be incorporated in the soil upon its disintegration and decay.

Growing alfalfa. The growing of alfalfa is no longer a mystery. An Illinois farmer writes, "During the unusually dry period of 1913 we harvested on our farm three full crops of about three and a half tons per acre and permitted a good fourth crop to remain on the land for winter protection. We thought that $66.50 per acre was sufficient for an unfavorable farming year like 1913."

There are many good reasons why more farmers should grow alfalfa. There need be no fear of overproduction should it result in the feeding of more live stock—an operation profitable both as a business and as a soil builder. In brief, alfalfa improves the physical condition of the soil by adding organic matter and by loosening it, owing to its deep roots. It improves the chemical condition by adding nitrogen and, in its disintegration, by liberating other plant-foods. It furnishes a forage food of first rank for the live stock on the farm, and as long as it sells from $15 to $20 per ton it will tend to fill the purse of the farmer as well.

Soil requirements. Soil upon which alfalfa is to be grown should be well drained and should contain a good supply of organic matter, lime and phosphorus. On well-drained corn soils, liberal applications of limestone, two to five tons per acre, will usually prove helpful and profitable. In order to give alfalfa a good start, some phosphorus can be applied with profit. Five hundred pounds per acre of fine ground steam bone-meal or acid phosphate is quickly available plant-food for this purpose. Any good well-drained soil with plenty of lime, active organic matter, and phosphorus will grow alfalfa, providing there is no hard pan or rock within three

or four feet of the surface to interfere with the development of the alfalfa root.

Seeding alfalfa. Alfalfa may be seeded in April if the soil is free from grass and weed seeds. June and July seeding give good results, but under favorable conditions best stands may be secured from August and September seeding. Many favor spring sowing with one bushel of oats per acre as a nurse crop. In this case it is best to mow the oats for hay before they mature. With this plan it is sometimes possible to harvest a fair crop of alfalfa in August. Alfalfa should not be pastured the first year. Fifteen to eighteen pounds of seed per acre is sufficient.

In order to give alfalfa the best possible conditions, the ground should be prepared with great care. It should be plowed in the fall or early spring, and then stirred at least once a week from early spring until seeding time. Disking, harrowing, and rolling the ground in order to keep it worked up before seeding not only prepares a good seed-bed, but helps to keep out grass and weeds and to conserve the moisture.

The ground may be prepared thoroughly after winter wheat or oats have been harvested, and if there has been sufficient summer rainfall to supply moisture, alfalfa may be seeded and get a good start without the loss of a season's crop.

Inoculation. When alfalfa is sown for the first time in a field, inoculation is necessary to establish a permanent crop. The alfalfa plant will not get enough nitrogen from poor soil to insure successful growth without the aid of the bacteria which are able to utilize the free nitrogen of the air. These

bacteria must be supplied if they are not present. This is best done by scattering over the seed-bed just before or after seeding about half a wagonload per acre of natural, well infected soil, collected where tubercles containing the bacteria are found in abundance upon the roots of alfalfa or sweet clover plants. This infected soil should be immediately harrowed in with the alfalfa seed. Care must be taken that the infected soil is not left exposed too long to bright sunlight, because sunlight destroys the bacteria. The glue method of inoculation is also practical. (See 4 below.)

FIG. 6. HARVESTING ALFALFA

Cutting alfalfa. Alfalfa should be cut the first season whenever it seems to stop vigorous growth. In no case should any weeds be allowed to develop seeds, even if the alfalfa must be clipped and left to lie on the ground. The crop may be cut every five or six weeks. The rule commonly followed is to cut alfalfa when the new shoots from the crown are about one inch long. In the fall it should not be cut very late because of danger from winter killing. The practice of

cultivating alfalfa after early season cuttings is recommended by some successful growers. The knives should not be set too slanting to endanger cutting off the crowns of the plants. Sometimes a spring tooth harrow is used. A corrugated roller following the cultivating will help loosen the soil and make an effective soil mulch.

Alfalfa hay is cured and harvested in about the same manner as red clover. It must not be allowed to lie in the swath to cure until the leaves, the most valuable part of the hay, are likely to be broken off and lost in the handling.

The partly cured hay is put in small haycocks and covered with haycaps for protection against the rain. These caps are made of canvas about forty inches square and held in place by balls of cement, each carrying a wire hook. It should remain in these haycocks until well cured; usually from two to four days are necessary.

Summary of Directions for Growing Alfalfa

1. Select a deep, well drained, fertile soil, as free as possible from weeds.
2. Before attempting to grow alfalfa it is well to grow a tilled crop a year or two previous to seeding the alfalfa.
3. Prepare the seed-bed thoroughly; an ideal onion tilth is best.
4. Inoculate the land with from 100 to 300 pounds per acre of infected soil. If care is taken to prevent the alfalfa seed from gluing together, the glue method of inoculation may be used. Moisten the seed with a 10 per cent solution of glue (six ounces of furniture glue to one gallon of water) and immediately sift over them sufficient dry, pulverized, infected

soil to absorb all of the moisture, thus furnishing a coating of infected soil for every seed.

5. Apply at the outset, on worn soils especially, 400 pounds per acre of some good carrier of phosphorus, and if the land lacks organic matter apply manure liberally.

6. Apply from two to five tons of ground limestone per acre to the soil the previous fall or early in the spring before seeding.

7. Seed the ground with a nurse crop of oats or barley in April, or sow alone on ground that has been thoroughly prepared between the fifteenth of July and the fifteenth of August with fifteen to twenty pounds of seed, and cover lightly with a smoothing harrow or weeder.

8. Roll or firm the ground with a plank drag after planting.

9. Avoid clipping or pasturing after the summer seeding.

10. Cultivating the ground after the cuttings of alfalfa destroys weeds, loosens the ground, and encourages the growth. After five years the alfalfa field may be plowed up and included in a crop rotation, beginning with corn.

Notebook Questions

1. Why have there been so many failures in trying to grow alfalfa in this country?

2. Why is alfalfa a good forage crop?

3. Show statements explaining the probable costs and profits in growing an acre of alfalfa.

4. Name the requirements for growing alfalfa in the order of their importance.

5. Compare alfalfa and red clover as to habits of growth, culture requirements, feeding value, and place in crop rotation.

Practical Exercises and Home Projects

1. **Field study of alfalfa.** Location visited............. Date.................... If possible, visit an alfalfa field, observe the following points, and write a description of each point from the field study:

   1. Number of plants per square foot. Average five.
   2. Height of plant. Average ten.
   3. Number branches per stem. Average five.
   4. Number shoots per crown. Average five.
   5. Diameter of taproot at crown base.
   6. General appearance of field as to thrift and color.
   7. Note the strong taproot with branches.
   8. Note number and position of lateral stem buds.
   9. Select as large a plant as possible, and carefully dig away the soil, removing the plant with the taproot and its branches. Sketch.
   10. Note the nodules and their position.
   11. Remove a few of the nodules and preserve them for further examination.
   12. General description of leafy portion.

2. **Growing a plot of alfalfa.** If this study is made at the proper season, one practical exercise on alfalfa should be made by growing at least one-tenth of an acre on the school grounds. Prepare the ground, and follow carefully all directions given in the discussions above in making this demonstration plot of alfalfa.

3. **Examination of alfalfa seed for purity.**

(a) Examine the seeds, become familiar with their form and size. Sketch a few seeds.

(b) Count out one hundred seeds from the sample in hand. Separate from this lot all weed seeds and estimate the per cent of purity.

At the current price of alfalfa, what would a bushel of pure seed cost? How much would you have to buy of the quality you have just examined to get a bushel of pure seed?

(c) List the names of the weed seeds you find in the sample of alfalfa seed.

CHAPTER VI

MEADOWS AND PASTURES

Our most important crop. The plants that grow in our meadows and pastures constitute our most valuable agricultural crop. The grasses and the legumes feed both our animals and our economic plants, as we shall learn later in our study, and the meadows and the pastures contribute no small part to the beauty of the landscape in the open country.

Forage crops. All such food for animals as grass, hay, pastures, etc., are known as forage crops. *Fodder* is the forage dried and cured. *Green fodder* is forage cut and used before it ripens. *Silage* is chopped green forage stored in a silo. *Stover* is cornstalks from which the ears are removed. A *soiling crop* is one which is cut and fed green to animals. There are about fifty forage crops, classified as follows:

1. *Perennials*—Timothy, red-top, blue-grass, orchard grass, etc.
2. *Legumes*—Alfalfa, clovers, peas, beans, vetches, etc.
3. *Annual forage plants*—Oats, millet, Sudan grass, kaffir corn, corn, etc.

Meadows are fields used for growing forage plants to be cut for hay. Pastures are fields used for grazing purposes. Permanent pastures are devoted to perennial grasses.

Hay. The hay crop of the United States is exceeded in

value by only one other crop; namely, corn. Almost all of our hay is made from such plants as timothy, clover, alfalfa, cow-peas, and millet. The pasture grasses are blue-grass, buffalo grass, red-top, and clovers. Of the thousands of species of grasses only about twenty-six are cultivated, and only nine are considered as important farm crops. In the order of their importance the meadow grasses are: timothy, Kentucky blue-grass, Bermuda grass, orchard grass, red-top, Russian brome, meadow fescue, tall meadow oat grass, and meadow foxtail. The total yield of timothy in this country is greater than that of any other hay crop. The hay is palatable, easy to cure and keep, and is standard on all the world markets. For these reasons timothy continues to be the leading hay crop of the country. These facts, however, do not justify the encouragement of the production of timothy when we have better hay crops available both from the standpoint of animal feeding and soil fertility. Combinations of grasses and perennial legumes are preferable to any single grass for hay making or for pastures. For pastures, those maturing at different periods are grown; for meadows, those maturing at the same time are necessary.

Seeding for hay and pastures. In the hay-producing regions of the United States a mixture of timothy and red clover is the combination used. From four to six pounds of seed of each are usually sown to the acre in starting a meadow. The first year the hay is a mixture of the two. After the second year the stand is nearly pure timothy. The grass seed is usually sown in the fall either with or without a nurse crop. The clover is usually sown the following spring. Ken-

tucky blue-grass is the most highly esteemed pasture grass in America. Blue-grass and white clover will soon take possession of most permanent pastures; therefore there is little need of sowing any other seed for pastures.

Renewing meadows and pastures. When meadows and pastures become very weedy, plowing and re-seeding is the only effective way to renew them. A crop of corn and oats may be grown in the meantime on the land. Grass of old meadows and pastures may be revived by liberal top-dressings of barnyard manure in August or September. Persistent cutting when weeds are in blossom is the only effective way of holding them in check and thus keeping the pastures clean.

Notebook Questions

1. Name nine grasses and seven legumes used as forage crops. Define grass and legume.
2. Where are the great pasture regions of the world?
3. How does the hay crop compare in value with other farm crops?
4. How do grasses reproduce?
5. In what stage of development do the farmers of your community cut the timothy hay?
6. How would you start a good meadow? A good pasture?
7. Ought we to grow more or less timothy hay in the interests of live-stock farming and permanent soil fertility? Why?

Practical Exercises and Home Projects

1. **Identification studies of forage crops.** Either in the field or in the laboratory, spend the period in examining

the grasses and legumes usually grown in meadows and pastures. List the *common names;* state whether *perennial,* or *annual, grass* or *legume; method of propagation; uses for which grown;* and *other most important characteristics.*

2. Visit a meadow or a pasture and write a critical article about it, noting such points as—

(1) Soil condition.
(2) The plants grown.
(3) The cleanliness of the field as to weeds, brush, etc.
(4) Improvements needed.

CHAPTER VII

CORN

"The rose may bloom for England,
  The lily for France unfold;
Ireland may honor the shamrock,
  Scotland the thistle bold;
But the shield of the great Republic,
  The glory of the West,
Shall bear a stalk of tasseled corn,
  Of all our wealth the best.
The arbutus and the golden-rod
  The heart of the North may cheer,
And the mountain laurel for Maryland
  Its royal clusters may rear,
And the jasmine and magnolia
  The crest of the South adorn,
But the wide Republic's emblem
  Is the bounteous golden corn."

—*Edna Procter.*

I. Corn, the Great American Cereal

Indian corn. No one knows the entire history of Indian corn, whose special name is given as maize. The name itself contains a bit of history. Columbus found a strange plant on the Island of Hayti, which the natives called "mahiz," and from this we have the name maize. Botanists have called the plant Zea mays, the second or specific name being a modification of the old Indian name.

The early explorers of America found the new corn in

the temperate regions of both Americas. We are particularly interested in the history of corn after the discovery of America because of its importance as a food crop to the early colonists. John Fiske, in his history of the discovery of America, declares that Indian corn was of "incalculable advantage to the English settlers of New England, who would have found it much harder to gain a secure foothold upon the soil if they had had to begin by preparing it for wheat and rye without the aid of the beautiful and beneficent American plant."

Importance of the corn crop. It is not easy to appreciate the importance of corn in the agriculture of the United States. Most people are aware of the fact that corn is our principal grain crop. Many do not know how important it is in comparison with other grain crops. The following table, compiled from the estimates of the Bureau of Statistics of the United States Department of Agriculture, will furnish a basis for some interesting and instructive comparisons of the relative importance of a number of the crops for the year 1910:

	Acreage	Production	Value, Dec. 1
Wheat	49,205,000	695,443,000	$ 621,443,000
Oats	35,288,000	1,126,765,000	384,716,000
Barley	7,257,000	162,227,000	93,785,000
Rye	2,028,000	33,039,000	23,840,000
Rice	722,800	24,510,000	16,624,000
Buckwheat	826,000	17,239,000	11,321,000
Potatoes	3,591,000	338,811,000	187,985,000
Total	98,917,800	2,398,039,000	$1,339,714,000
Corn	114,002,000	3,125,713,000	1,523,968,000

Thus it appears that in acreage, production, and value, on December 1 the corn crop of 1910 was greater than all of the other cereal grains, including also buckwheat and potatoes.

II. Types of Corn

Dent and flint. In speaking of the several types and varieties of corn, most of us use the terms rather loosely. Shoesmith in his "Study of Corn" describes six types: the dent, the flint, soft corn, pod corn, sweet corn, and popcorn. The types with which farmers of the corn belt have most to deal are the *dent* and the *flint* corn. There are many varieties of both dent and flint types. The difference in appearance of the several types of corn is due in part to differences in structure, and in part to differences in composition. In the dent type the soft endosperm appears white and starchy at the center and near the crown of the kernel. As the grain ripens this soft endosperm shrinks more rapidly than the horny endosperm which is located chiefly at the edges of the kernel, and the result is the folded or wrinkled appearance of the tops of the grains of dent corn. In the flint corn the soft endosperm in the center of the grain is surrounded by the horny endosperm, so that the ripening grain shrinks almost uniformly, leaving a smooth, shining surface.

Varieties. Some standard varieties in the corn belt are: Boone County White, Funk's Yellow Dent, Leaming, Minnesota No. 13, Reid's Yellow Dent, Silver Mine, Silver King (Wisconsin No. 7), and Johnson County White. Descriptions of these and other varieties are fully given in Shoe-

smith's "Study of Corn," and Bowman and Crossley, "Corn."

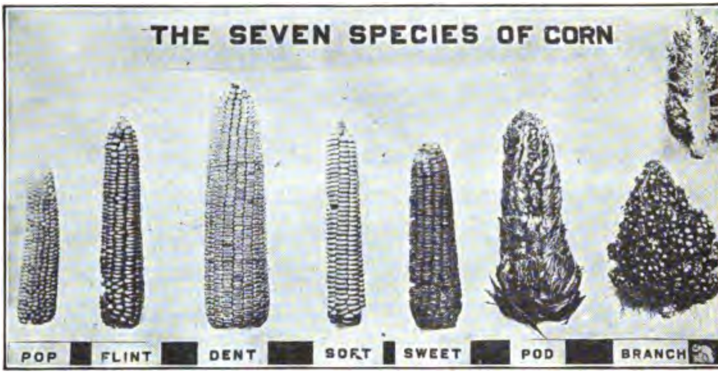

FIG. 7. SEVEN SPECIES OF CORN

III. Life History of the Corn Plant

The life cycle. Every living thing has a life history—a beginning, a growing, possibly a reproduction, and a death. So it is with the corn plant. We may begin at any place in a cycle, but in case of the corn we shall begin with the seed. The young corn plant is already well started in the seed. It has a stem and leaf-end embedded in a cotyledon containing food for the young plant, as soon as conditions are right for it to continue its growth. These conditions are right when the kernel of corn is planted in the soil. Here the moisture, heat, and air cause the young plant in the cotyledon to begin to grow. This growth consists in putting out roots into the soil, pushing up a roll of leaves into the

light and air, and using up the food in the kernel. When the roots are established in the soil and the leaves are unfolded in the air, then the plant begins to feed upon the mineral food elements in solution in the soil and the carbon dioxide gas of the air, and to combine these food elements into compounds to be assimilated into the growing roots, stems, leaves, flowers, and grain during the summer. At the tip of the cornstalk the tassel containing millions of pollen spores develops, and on the side of the stalk the ear develops, each kernel of which sends out a long silk to the end of the husks, where they appear in a beautiful yellow mass. The pollen must fall upon the silk, one spore upon each silk, where it grows a long tube reaching down the silk to the corn kernel at the cob. The kernel is then fertilized, the young corn plant begins to grow in the kernel, and continues to grow until the corn is matured. The old corn plant then dies, and all that is left alive is the germs or new corn plants embedded in each kernel of the ripened ear of corn, ready to germinate and continue the life history another year as described above.

IV. The Corn Plant

Corn—A grass. All of the cereal grains except buckwheat belong to the family of grasses. Corn is a very wonderful grass. On the tenth of May, or even two weeks later, the corn plant is snugly folded within the kernel. A week or two after being planted, the young shoot pushes its tip out of the ground and begins to be a real plant—a growing thing with

roots in the ground and green leaves spreading out in the air. In another hundred days, or even less, the corn may be in the shock. What has happened meanwhile?

Corn roots. First, the developing corn plant had to extend its root system deep and wide in the ground. It has been shown that in thirty days after planting the roots of corn plants in adjacent rows meet and interlace. They fill the whole surface of the cornfield with a network of roots, and in many cases these roots extend several feet downward. While the roots are reaching everywhere in the surface soil, the stalks are reaching upward and spreading out their broad blades to the sun and air.

Leaves and blossoms. The corn plant does more than grow tall and strong; it throws out brace roots enabling it to resist the winds. It produces broad leaves in such a way that the wind may bend them and toss them with little danger of breaking them; for the leaves are many, broad, and long, in order to give the corn plant enough feeding surface exposed to the sun and air. The corn plant has a wonderful contrivance for producing its fruit, as explained in a former paragraph. Silk and tassel are the flowers of the corn plant. Every future grain on the ear is at the lower end of a long thread of silk, but the grain can not develop until a particle of pollen from some tassel falls upon its tip and grows down the silk to fertilize the seed.

During its short growing season the corn plant may grow to a height of from ten to fifteen feet, and produce an ear or more of corn. A good ear of corn may contain a thousand or more kernels.

V. Place of Corn in Crop Rotation

Reasons for rotation. At the basis of all successful farming is an intelligent practice of crop rotation. Early in our study of corn, therefore, it is well to learn its place in systems of crop rotation.

A few of the more particular reasons for the rotation of crops are as follows:

1. Different crops make different demands upon the soil. The grain crops are able to use a large part of the available phosphorus and potassium of the soil, but less of its nitrogen; therefore it is well to follow the grains with crops which use nitrogen more extensively and do not draw much upon the supply of phosphorus and potassium in the soil.

2. Root systems differ. The small grains are shallow-rooted, and so utilize the fertility from the surface portion of the soil. Other crops, such as clover and alfalfa, send their roots deep into the soil, and so secure plant-food that is out of reach of such crops as wheat and oats. Besides, clover, alfalfa, and other leguminous crops when plowed under leave the soil richer in nitrogen than they find it. This adds greatly to the productiveness of the soil for crops of a different character.

3. The culture of one crop prepares for a succeeding crop of a particular kind. It is common in the wheat sections to follow corn with wheat because summer cultivation of corn makes it possible to sow the wheat without plowing. Besides, the well tilled corn ground enables the wheat to get a good start in the fall, and to make use of a considerable part of

the plant-food made available by weathering during the fall, winter, and spring.

4. Distribution of labor. The farmer who has a well planned system of rotation is able to make better and more continuous use of his own time and of the labor of his men and teams.

Corn in systems of rotation. Rotation of crops will not in any sense add to the fertility of the soil, unless in the rotation a legume crop be returned to the soil, and then nitrogen only is added. In connection with the following rotations, discussion will be made later as to the place of mineral plant-foods in keeping up soil fertility.

For a system of rotation in live-stock farming, the follow-lowing scheme is advised:

(1) Wheat, (2) corn, (3) oats, (4) clover, and (5) one-fifth the land in alfalfa to be turned into the rotation after five years, and another one-fifth seeded to alfalfa. Sell all grains, seed, and alfalfa hay, and return the rest to the soil, using limestone and rock phosphate, as will be explained later.

For a system of rotation in live-stock farming, the following is recommended:

(1) Corn, (2) corn, (3) oats, (4) clover, and (5) alfalfa as before. Feed all the crops and return the manure to the soil, using limestone and rock phosphate.

VI. Fertilizing Corn Ground

Corn not a poor land crop. It needs to be repeated again and again that corn can not be profitably raised on poor

land. It costs as much to plow and otherwise prepare poor land for a crop of corn as it does to prepare good land; the subsequent cultivation is just as expensive, and every step in the progress of raising a poor crop from poor land is practically as costly as every similar step in producing a good crop from good land. Year after year some men raise corn on land so poor that with the best cultivation only a small crop can be raised, and this always without profit. Why not bring the land up to the condition which will make it permanently profitable?

Soil upon which corn is to be grown often responds with increased yields through crop rotation, the growing of clover, even though it be removed, and the use of complete commercial fertilizers; but these methods do not provide for permanent soil fertility, nor do they always return a profit on the investment.

Permanent soil fertility. There is a difference between adding complete commercial fertilizer even though increased crop yields result, and the maintenance of permanent soil fertility at a lesser annual yield. It is to be correctly inferred from the above that the use of complete commercial fertilizers does not maintain permanent soil fertility, and no one can deny that we should keep a permanent if not an increasing soil fertility.

How can this be done is the practical question to raise. How can we feed the corn and keep the soil fertile? To begin at the beginning, let us take a typical Middle West acre. The first requirement is that the soil should be well drained. The next is that it shall have plenty of active

organic matter. If clover or other legumes will not grow well to furnish this organic matter, perhaps the soil is sour and needs from two to five tons of ground limestone to the acre. The next important requisite is the nitrogen content.

FIG. 8. POT EXPERIMENTS WITH FERTILIZERS

This is best supplied by the clovers which also furnish the organic matter. To get the addition of nitrogen the clover must be plowed under. The next requisite in most soils is the maintenance of an adequate phosphorus supply. This is most economically supplied by the use of from one to three tons of fine-ground rock phosphate to the acre. This must always be applied, however, where manure or other organic matter is incorporated in the soil; for the decaying of the organic matter is necessary to render the phosphorus in the rock phosphate available for plant-food. This decaying

organic matter also renders available the potassium which in normal soils is usually in sufficient abundance to supply standard yields. This method of supplying plant-food to the soil in connection with good systems of crop rotation not only increases the annual yields of each crop in the rotation, but leaves the soil permanently richer in plant-food after the single applications, as stated above, and after four or five crops of the rotation have been produced.

Plan of soil treatment, the corn series. The following is the general plan of soil treatment for ten plots in each of a series of five at the University of Illinois. The figures show the yields of corn in one season:

Plot No.	Soil treatment	Corn yield bushels
1	None	60
2	Legume (catch crops and crop residues)	60
3	Manure	75
4	Legume, lime	65
5	Manure, lime	80
6	Legume, lime, phosphorus	87
7	Manure, lime, phosphorus	90
8	Legume, lime, phosphorus, potassium	90
9	Manure, lime, phosphorus, potassium	93
*10	Legume (manure, lime, phosphorus, potassium, X5)	96

VII. Plowing for Corn

Time of plowing. The time of plowing for corn will usually be determined by the convenience of the farmer. It is a pretty well established fact that the differences in yield

*Five times the amounts used in (9) were applied.

on land plowed in the fall and similar land plowed early in the spring are very slight. Sticky clay land should not be plowed when it is so wet as to slip off the mouldboard in a shiny condition. Land that is likely to wash because of steepness or other conditions should be plowed late in the winter rather than early, especially if it is protected by a cover-crop.

Purpose of plowing. One purpose of plowing is to enable the land to store water and retain it. Fall plowing provides for the storage of water in the soil; spring plowing provides for its retention. But to this qualification there needs to be added the statement that spring plowing is likely to hasten the evaporation of soil moisture unless the plow is almost immediately followed by the harrow. Water escapes very rapidly from the surface of a newly plowed field. Following the plow with the harrow while the surface soil is still fresh reduces the exposed surface and so retards evaporation. It also retards the rise of the water from the subsoil, thus retaining it where the plant roots will need it during the growing season. Plowing also increases the feeding area of the corn roots and helps to make plant-food available.

Depth of plowing. The depth of plowing for corn will be determined largely by the depth of previous plowings. It is not wise to turn a large amount of raw subsoil up to the surface. Usually it is well to bring a small amount of new soil under the direct influence of sun and rain, thus preparing it to be useful to subsequent crops. It is to be remembered that it is the mellowed soil that contributes most to

the growth of plants. Other influences have much to do with determining the proper depth of plowing for corn. If the ground is plowed in the fall, it may be safe to plow an inch or more deeper than it would be wise to plow the same ground in the spring. The frosts and freezes of winter will do much to mellow and "tame" the soil that has never been exposed to the more active weathering influences.

If much organic matter is to be plowed under, it should be done in the fall in order to give it time to decay before the spring crop is planted.

Preparation of seed-bed. Broadly speaking, everything done to the soil is a part of the work of preparing the bed for the seed to be sown or planted. Plowing and fertilizing the ground are steps in the preparation of the seed-bed, but we must be concerned here with the immediate preparation of the soil to receive the seed. The use of the harrow after the land has been plowed for corn is the simplest method of preparing for planting. On land plowed in the fall or early winter, it is advisable to go over the ground once or twice with the disk or cutaway harrow before using the smoothing harrow; and in many cases the roller or wooden drag may follow the other implements with profit. A modern implement known as the "culti-packer" seems to make ideal seed-bed preparation, since it both packs and mulches the soil. Finally, after the corn has been planted, further preparation of the soil for the growing corn may be made by going over it once or twice with the smoothing harrow. A seed-bed in perfect condition to give the corn plants the best kind of a start is almost equivalent to a guarantee of a good crop.

VIII. Testing Seed Corn

Will the corn grow? The farmer plants corn in the belief that it will grow. Why should not every kernel sprout and produce a good stalk to bear a good ear? Perhaps it would if every condition were made right. The kernel itself is the first condition; it ought to be in perfect growing condition. The corn judge or the man selecting seed from the crib can not make a germinating test; he must be guided by appearances. What are some of the evidences that corn will probably grow?

If the ear is firm in the hands, the kernels tight in their places, and no evidence of decay seen at the butt, it may be supposed that the corn is matured and well developed. The kernels should be hard and dry and without dullness of color; they should be of a fairly large and regular size, with large and healthy germs, and there should be no sign of mold. The tips of vigorous kernels are never thin and shrunken. They should be free from cracks and blisters, and tip caps should completely cover the tips of the shelled kernels. The corn should be dry, firm, and bright colored. A damp moldy cob indicates weakness in the germ, and it may mean that the germs are already dead.

The germination test. The final proof that the corn will grow is the germination test. The man who risks a large share of his year's labor in his cornfield ought to be perfectly sure that his seed is good; the actual sprouting of a few grains from every ear will make him perfectly sure.

The test-box. Make a box of any convenient size. A

board ten or twelve inches wide and two feet long will make the bottom of a very serviceable tester. Make a tray or shallow box by using two-inch-wide boards for the sides and ends. Fill this tray with sand, leveling it with a yardstick, a lath, or any straight-edged piece of wood or metal. Lay it off in squares by driving a row of carpet tacks into each side and each end of the tray, placing these tacks an inch and a half or two inches apart, and lacing strong twine back and forth across the box from end to end and from side to side. The twine will thus serve as a fence around each of the squares, which will be an inch and a half to two inches across, depending on the distance between the tacks, and will provide space to test five kernels.

This is the tester complete, except for a means of making and keeping a record of each ear to be tested. Begin at the right-hand corner of the box and number the long way of the tester from 1 to the number representing the number of squares in the long row. If the squares are two inches in size and the tester is four feet long, the last number will be 24. Then begin at the corner numbered 1, and number the short way of the tester with the letters of the alphabet. If the box is a foot wide and the squares two inches in size, there will be six squares in a short row, and they will be numbered from A to F. The row of squares numbered 1 will cross the row marked A at the corner of the tester. This corner is marked A and 1; in brief, it is A1. The square in the opposite corner is F24. Any other square is definitely located by letter and number. Thus provision is made for testing 144 ears of corn. If the squares are made

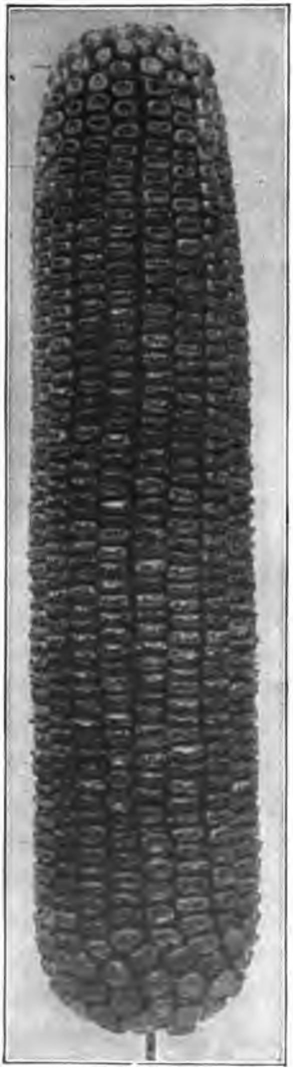

FIG. 9. AN IDEAL EAR

one inch across, there will be 576 in a tester a foot wide and four feet long, inside measure.

Made according to these directions, the tester provides a simple means of keeping a record of every ear tested. Cut a piece of cardboard into squares half an inch across. Fasten one of these to the butt of each ear of corn by using a common pin. The pin will hold the bit of cardboard, providing a place for the number to correspond with the square in which grains from each ear are to be planted.

With the tester in a place where the sand can be properly moistened with water, and where it can be kept moist and also warm enough to allow the corn to germinate at a summer temperature, begin the work by taking an ear to be tested in square A1; mark the tag pinned on the butt of the ear (the pin thrust deep into the pith) A1; then, with a pocket knife carefully lift five kernels from different rows in different parts of the ear.

Placing the kernels. The kernels are now ready for planting, which may be done by pressing them germ side up into the sand of the square set apart for them. Mark the next ear in the same way, A2, and plant five grains in square A2; following this method until five grains have been planted from the last ear in (it may be) square F11, or any other square. Now you are prepared to wait for the corn to come up. The marked ears are laid aside where they can not be disturbed by mice, rats, or meddlesome persons; the tester, with every grain of corn pressed just below the surface of the sand, is sprinkled with water, and then covered with moistened muslin or other cloth to keep the test-box from drying so fast.

Results of test. If any ear of corn shows less than perfect germination in every kernel taken, that ear should be discarded. It is not safe to plant seed from an ear that shows any weak or dead kernels. Perhaps the simplest and most important lesson to get from this study is that no one should plant corn that is not known by actual and careful test to be in perfect germinating condition. If seed corn has to be bought, it should be bought in the ear so that the purchaser may know what his corn is and may test it for himself.

IX. Planting the Corn

Time to plant. Early planting is generally advised, but corn is a warm weather plant. It will not germinate until the soil has become warmer than is necessary for the growth of peas, oats, and certain other hardy plants.

Distance in planting. The distance between rows is usually a matter of custom, growing out of local experience. Forty-four inches is a common distance. If the corn is planted with a check-row planter, it may be planted forty-four inches each way. When corn is drilled, the distance between rows is sometimes three feet and six inches. When planted in hills, and the seed is good, three kernels to the hill will produce the desired number of stalks.

Depth of planting. The depth of planting should depend on the season, the kind of soil, and its condition. If the corn is planted early while the soil is comparatively cold, shallow planting is to be recommended. When the soil has become warm and mellow, deeper planting may be safely done. It should be remembered that corn kernels will not sprout unless they get sufficient moisture, and at the surface of a dry soil there may not be enough moisture to cause prompt germination.

X. Cultivating Corn

Purposes of tillage. Tillage breaks up the soil, making possible the free movement of air and moisture. It mellows and pulverizes the soil, thus promoting the processes that increase the availability of the plant-food materials; it promotes the warming of the earth, and destroys weeds.

First cultivation important. This first cultivation of the corn may be done with a two-horse, double-shovel cultivator. If such an implement is used it should be supplied with fenders to keep the young plants from being covered or

broken by the earth thrown against them by the rapidly moving shovels.

The importance of this first cultivation can hardly be overemphasized. It should not be done when the ground is too wet; it should not be put off until the weeds begin to smother the corn plants. Many a corn crop has been reduced in yield from a fourth to a half by neglecting to use the right implement in the right way at the right time.

Every man ought to be so familiar with his own soil and its condition that he can judge the right time to cultivate by looking at it, by walking over it, and by feeling of it with his fingers. If the ground is too wet, there is danger that serious harm will be done by the cultivator; if it is allowed to get too dry, there will be great loss of moisture due to evaporation and the growth of weeds.

Shallow cultivation. Much damage is done to corn every year by too deep cultivation. By the time corn is a foot high, it will not be possible to give it deep cultivation without breaking off many of the roots. This will give the corn a serious set-back.

With the plowing well done in fall or winter or early spring; with thorough preparation of the seed-bed by the use of disk or cutaway, and smoothing harrow and roller or plank drag; with one deep cultivation well and carefully done; after this it is easy to do the work that will ordinarily assure a good crop of corn on fairly rich land. The subsequent cultivation should be shallow. In fact, some corn growers advocate merely scraping the surface of the ground to destroy weeds and provide a soil mulch.

The soil mulch. By the use of the right kind of implements and a knowledge of the principles of tillage, the farmer keeps the soil in proper condition and prevents the growth of weeds. If a hard crust is formed on the surface of the soil by the dashing rains of summer, the soil water rapidly comes to the surface and is evaporated by the sun and wind. The farmer wants to have this water escape from the soil through the corn plants, giving up on the way the plant-food it has absorbed out of the soil. He therefore breaks up the crust of earth and saves the moisture for the corn crop. The moisture from the deeper soil gathers below the mulch about the roots of the corn where it can be utilized. If weeds are allowed to grow, they will be sure to get their share of this moisture, thus robbing the corn.

XI. Maturing of Corn

Corn should mature. To be reasonably satisfactory for general use corn must also get ripe. We want the corn to use the entire growing and ripening season; but we do not want it to be of a kind that needs two weeks more of growing weather than our climate can furnish. We want corn that will mature.

Large ears and maturity. The common disposition of farmers to select large ears has had a tendency to produce a strain of corn requiring a long season—a season longer than can be depended upon year after year. So it often happens that, with a late spring or an early fall, or both, a large share of the corn does not get ripe. When cut before

it matures, it is so full of water that it can not dry out before freezing weather. The result is that the frost kills or weakens the germs of the unripe corn, making it unfit for seed. Another effect of the imperfect ripening is seen in the many cribs of moldy corn. Whenever there is a large proportion of soft corn, there is great danger that there will be heating and subsequent molding in the crib.

Where to get seed. The fact needs frequent emphasis that it is not wise to bring seed corn from a distance. The corn plant has a tendency to adapt itself to the length of the season; but this adaptation does not come about in a single season. The best practice is to plant home-grown seed from soil similar to the soil in which it is to be planted. If good seed can not be had from near home, the grower will do well to send for seed grown where the season is shorter rather than longer than his own.

XII. Selecting Seed Corn in the Field

Value of good seed. The importance of selecting good seed corn and taking good care of it cannot be over-estimated. Experiments have shown that well-bred and carefully selected seed corn, of a type suited to the soil and climate where it is to be used, will produce from 10 to 50 per cent more corn per acre. Rich soil and good culture are important factors in producing a large crop of corn, but good seed will add considerably to the yield.

Field selection. To get the best seed corn it should be selected in the field after it has matured, and while the char-

acter of the parent stalk can be seen. It is a well known law of life that "Like begets like," and, in the case of corn, each kernel selected for seed will tend to produce a stalk and ear like the one from which it came. Now there are certain desirable characteristics of the stalk of corn which can not be seen except by careful field selection.

There should be a large leaf growth. The stalk should be strong and vigorous, medium size, strong at the base with good brace roots and tapering gradually to the tassel. It should stand up well and bear its ear at a convenient height for husking. The shank of the ear should be of medium length, allowing the ear to turn down slightly. A short shank holds the ear too erect. Ears on long shanks or too high on the stalk are more likely to pull down the stalk in a wind storm, besides being inconvenient to husk. The ears selected should be well developed, with straight rows of uniform sized kernels. Ears should be selected and husked before the early frost injures them for seed. Expert plant breeders have selected seed corn for various characteristics and developed new and different strains from the same seed. This shows that it is possible to select seed and thus improve the strain from the old stock.

XIII. Judging and Scoring Corn

Corn judging. The object of corn judging is to determine the corn of highest quality, either for feeding or market, which is, consequently, most profitable to grow. The study of the desirable characteristics of seed corn has led to the

formation of a standard scale of points or "corn score-card." By the use of the score-card, the judge or student can keep in mind the relative merits of the points in a sample of corn, and compare the ears he is judging with the ideal standard.

FIG. 10. WINNER IN MANY CONTESTS

In selecting corn for seed or for exhibition, probably the best method is to place the ears from a bushel of selected corn upon a table with the butts of the ears toward you. Select the most nearly perfect ear you can find, one which

comes the nearest to the ideal type. Then select other ones resembling the first one—ten in all.

The score-card. The score-card is a device to help the judge or student to make intelligent comparisons of sample ears with the ideal type. The characteristics of the ear are listed and the perfect grade for each is given. The student must judge how nearly the sample being scored compares to the perfect grade under each point. In judging corn, ten ears usually constitute an exhibit sample. It is desirable that samples be laid out side by side on a table where a good light may be had.

For practical work in corn-scoring the teacher should provide score-cards used and recommended by the agricultural college of the state in which the work is being done. It is not advisable to give more attention and study to scoring corn than to its production. It is yield we want rather than fancy ears, and this characteristic is often inherent in ears of indifferent appearance.

XIV. Storing Seed Corn

Essentials of careful storing. The proper storing of seed corn after selection is perhaps of equal importance to the matter of selection. The ears should be taken when mature on the stalk and hung or laid in dry, well ventilated places, and kept perfectly dry and cool until planting time the next season. It must be remembered that the seed is a living thing and is injured by freezing.

Value of careful storage. The Ohio Extension Bulletin reports as follows: "Samples of seed corn were taken from over 100 different farms in all parts of the state, and germination tests made of the corn to determine its vitality, careful record being kept, as far as possible, of the method of storing and caring for seed corn."

The following table will give the results as shown by this preliminary work:

	Number tested	Range of germination—per cent	Average germination—per cent	Vigor of plants
Taken from ordinary crib...	40	55-100	85	Poor
Stored in good dry place with plenty of air currents, but no artificial heat, as on shelves, in cribs, above wagon sheds, hung by wires, strings, etc.........	62	72-100	90.3	Good
Stored in attics, empty rooms in houses, furnace rooms, etc. Some artificial heat furnished but not always a free circulation of air.....	11	85-100	93.3	Good

It was also shown in these Ohio experiments that seed corn from varieties that are well adapted is less difficult to care for than that from large, late-maturing strains.

"A bushel of seed corn will plant seven acres which at fifty bushels per acre should yield 350 bushels. It will be seen, according to the figures shown earlier in this discussion, one bushel of the corn which had been well cared for would produce 5 per cent more stalks than the seed not properly

stored. Not taking into consideration the difference in the vigor of the plants, this would make a difference of seventeen and one-half bushels in favor of the bushel of seed that had been carefully handled."

Methods of storing seed corn. There are many methods of storing seed corn, but in all cases the place of storing must be dry and well ventilated. It should never be put in boxes,

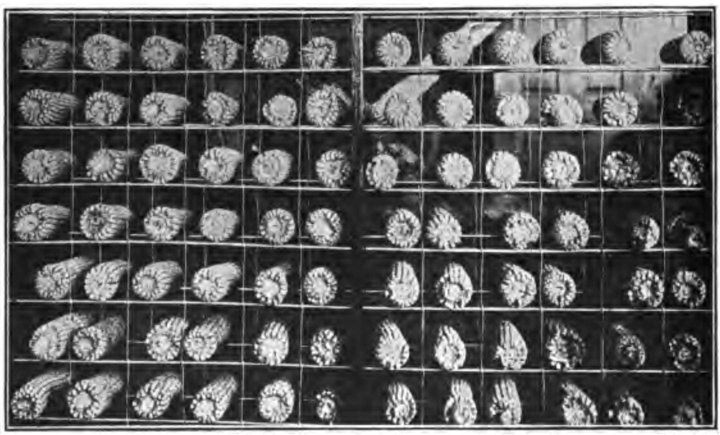

FIG. 11. SEED CORN RACK

barrels, or sacks. The attic, or an empty room upstairs in the house, if it is not too warm and close, is a good place for storing while the corn is still moist. The barn and crib are suitable places for storing if there is time enough for the ears to become thoroughly dry before freezing weather. If thoroughly dry and surrounded by dry atmosphere, seed corn will stand very cold weather.

No matter where stored, it should be either hung up or

placed on racks made of narrow strips with spaces between them, and in all cases kept out of reach of rats, mice, and chickens.

XV. Some Insects Injurious to Corn

The corn root-louse. Corn attacked by this insect becomes dwarfed, the leaves turn red and yellow, and there is general lack of vigor. The root-louse is a small insect, bluish-green in color, oval in form, with two short slender tubes projecting from the back part of the abdomen. The root-lice are nearly

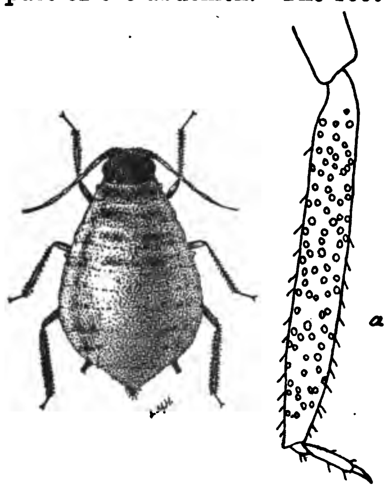

FIG. 12. CORN ROOT-LOUSE

always accompanied by ants, and the farmer who sees the ants about the roots of his corn is likely to lay the blame of his sickly crop to them rather than to the root-lice, the real pests. The ants, however, are indirectly responsible for the root-louse injury, as they care for the eggs of the louse during the winter, and bring the young lice to the roots of the young smart-weeds early in the spring.

About the first of May the second generation of lice appears, and the little brown ants transfer them to the roots of the young corn plants. During the summer the lice continue breeding with great rapidity, all the while sucking the juice from the young roots of the growing corn. About the middle of September the last brood of females begin to lay eggs for the winter. These females are usually carried by the ants to their nests, where the eggs are laid.

Rotation of crops, proper fertilization of the soil, deep fall plowing, or early spring plowing, followed by repeated

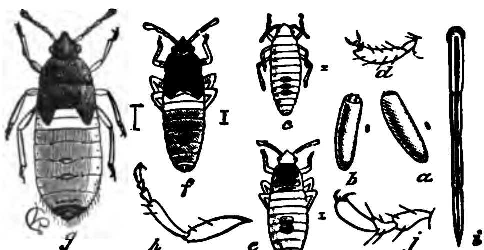

FIG. 13. THE CHINCH BUG

deep disking to destroy the ants' nests, are some of the successful methods of combating the corn root-louse.

The chinch bug. The great arch enemy of the corn crop is the chinch bug. This insect is about one-tenth of an inch long, and does its work of injury by sucking the juice from the stalks of the growing corn, completely destroying whole fields. The insect goes into winter quarters as an adult bug, and there remains until the warm weather of the next April or May. It is hidden away at the roots of various grasses, and in accumulations of weeds, leaves, and other rubbish.

Many bugs may be destroyed by burning such rubbish and grass. The bugs that live through the winter come out in the spring and spread over the country on the wing, settling in fields of wheat, early oats, or other grasses, and in these lay their eggs for the first generation of the year. The young hatching from these eggs injure the crop in which they find themselves. Later, at wheat harvest time, being only partly grown, they move out of infested wheat fields on foot into other fields of grain, especially of corn, where, if the season favors them, a second generation will be bred to the enormous injury of the infested crops.

The successful combating of chinch bugs is a community affair. Every farmer who has chinch bugs on his place should clean up and burn up all trash which would harbor the bug during the winter. In the summer the farmers of the community should all co-operate in throwing crude oil lines about their wheat fields to catch the bugs as they migrate from the wheat to the corn.

The corn ear-worm. The corn ear-worm injures the ears of corn and is a serious pest, especially to sugar corn. In the South this same insect is known as the cotton boll-worm, from its habit of boring into the boll of the cotton.

In our latitude the first broods of the moths appear in May and deposit their eggs on corn or other food plants. The second or third broods lay their eggs in the silks or tassels of the corn. The young worms hatch in three or four days, and begin feeding upon the silks of the corn. In a few days they get into the tips of the young ears. Each worm may feed upon several ears, and, when full grown, the

worms leave the ear and go into the ground, where they make little cells and in these transform to *pupae*. In about two weeks the next brood of moths appear. There are two or three broods in a year.

The pest is very difficult to combat. Since the pupae of the last brood hibernate in the ground during the winter, many of them may be killed by deep, late fall plowing. The time of planting should be taken into consideration; since the moths prefer to lay their eggs on the silk, the corn which is in silk when the moths emerge from the ground will be most seriously injured. Early planted corn is less liable to injury from this source.

XVI. Corn Products

The stalk. Many new uses have lately arisen for corn, in addition to the well known and standard purposes this cereal has long served. Corn pith has lately been utilized as a packing for battleships. The production of cellulose, high explosives, varnishes, etc., are recent uses of pith, and in the manufacture the outer shell and leaves of the stalk are left as by-products. These are finely ground up and put on the market as the "New Corn Product," which is used as a stock food. The crude stalk has such well known uses as stock food in fodder, ensilage, etc. A cheap grade of paper can be made from the pulp of the corn stalk. Denatured alcohol and various food extracts are being made from corn stalks.

The corn kernel. Besides the common uses of the kernel

as food for man and beast, there are about thirty products made from it: six kinds of mixing glucose, used by refiners of table syrups, brewers, leather manufacturers, jelly makers, fruit preservers, and apothecaries; four kinds of crystal glucose, used by confectioners; two kinds of grape sugar, used by brewers and tanners; pearl starch, used by paper and cotton-mills; powdered starch, used by baking-powder manufacturers; florine, used by flour mixers; dextrine, used by fine fabric, paper box, mucilage and glue manufacturers;

FIG. 14. ANALYSIS OF THE COMPOSITION OF CORN

corn-oil, used by table oil mixers, lubricating oil mixers, manufacturers of fibre, shade cloth, paint, and similar industries where vegetable oils are employed; corn-oil cakes, used for cattle feeding purposes; rubber substitute, used in the place of crude rubber; corn germs, from which oil and cake are made; British gum, a starch which makes a very adhesive medium; distilled spirits, used in the manufacture of smoke-

less powder; alcohol for commercial purposes; corn down, the brown outer coating next the cob, used in the manufacture of mattresses.

The cob. Even the cob, besides the emergency use as corks, is utilized in the manufacture of pipes, and as a fuel in the great corn belt. The ashes of cobs are easily convertible into a commercial potash.

Notebook Questions

1. Why is corn sometimes called Indian corn or maize?
2. How does corn rank in acreage, production, and value with other farm crops of the United States?
3. The corn crop for the last five years in the United States has been over 2,500,000,000 bushels a year. How much is that for each person in the United States?
4. How much corn was grown in the state last year? What was the average yield per acre? (See the *Year Book* of the Department of Agriculture, Washington, D. C. The school may obtain a copy through the congressman of the district.)
5. What are the parts of a kernel of corn?
6. What are the conditions for the germination of seed corn?
7. Where does the corn plant bear its blossoms?
8. A plot of ground at the University of Illinois has been in corn for thirty-five years. The yield is now about twenty-five bushels per acre. What does this show?
9. What do the farmers in your locality do to fertilize their corn ground?
10. In a system of crop rotation, including corn, oats, wheat, and clover, a farmer desiring to establish permanent

soil improvement applies two tons of ground limestone per acre to his clover field in the fall, and a ton of fine ground rock phosphate in the spring, before turning under the clover for corn. The limestone cost $1.50 per ton and the rock phosphate $7.50 per ton. His corn yield, as shown by check plots, was five bushels more per acre the first season, and twenty-five bushels more the fifth season; the oats increased twenty-five bushels, the wheat fourteen bushels, and the clover one ton per acre. Estimating the expense of applying the limestone and rock phosphate at 50 cents per ton, what did he gain on the investment at the prevailing prices of grain and hay?

11. A farmer turned under a heavy clover crop in the spring of 1913 and planted the field to corn. The corn germinated and grew well for a few weeks, then dried up and died. Explain.

12. What is the purpose of the germinating test?

13. If an ear of corn has 800 kernels and they should all be planted and all grow, producing ears that weighed 12 ounces each, how much would that ear of corn be worth, estimating its value from the yield at 50 cents a bushel?

14. What is the meaning of the term "tillage"? Name six values of tillage.

15. What should be done at the first cultivation of corn? Why is this cultivation so important?

16. Speak of the value of shallow cultivation as compared to deep cultivation of corn.

17. What harm results from weeds in the corn?

18. Why is it best to use home-grown seed?

19. Name some characteristics of the parent plant that are carried by the seed to the next generation.

20. Why is it best to select seed corn in the field? When should this be done?

21. How is seed corn stored and cared for at your home?

22. Make a list of uses to which you have seen corn applied.

23. Why is corn so well adapted to agricultural operations and commercial usage?

Practical Exercises and Home Project

1. **Observation study of a corn plant.** Bring half a dozen stalks of corn into the schoolroom or, better still, go with the class to a field of standing corn. Observe the stalks having roots, leaves, ears, and all complete. Make notes of your observations on each stalk, noting the following points:

    1. Leafiness of stalk, number of leaves.
    2. Size and vigor of stalk—measure exact height.
    3. Height of ear from ground.
        (a) Length of ear, angle with stalk, and length of ear shank.
        (b) Husks, abundant or scarce, close or loose fitting.
        (c) Ear, good or poor type.
    4. Are brace roots present?
    5. If hills of corn are 3 feet 6 inches each way, how many hills to the acre?
    6. If each hill has three corn stalks, and each stalk bears an ear weighing 12 ounces, how many bushels per acre would be the yield?

2. **Field selection of seed corn.** Bring several stalks of corn to the schoolroom, or go with the class to a field. Assign to each pupil a stalk of corn and have him write a criticism of the stalk as to whether it is suitable from which to select seed corn or not. Note the following points:

    1. Leafiness of stalk.
    2. Size and vigor of stalk.
    3. Root support.
    4. Height of ear.

5. Length of shank.
6. Angle of ear to stalk.
7. General type of ear.

3. **Study of an ear of corn.** (From Nòlan's "One Hundred Lessons in Agriculture.") With an ear of corn on the desk before each pupil, describe it, using the following outline:

1. Name of variety.
2. Color of grain and cob.
3. Surface, dent or flint.
4. Rows of kernels; number, straightness, spacing, and completeness.
5. Kernels, firm or loose.
6. Shape of the ear.
7. Butt; even, shallow or deep.
8. Tip; exposed or covered, nature of kernel at tip.
9. Kernel shape.
10. Length and circumference of ear.

4. **A grain of corn.** Soak a few grains of corn in hot water for twenty minutes. With a sharp knife remove the *tip cap,* a small cap covering the end of the kernel. Begin where the tip cap has been broken, and remove the hull in strips. The part immediately under the hull, covering almost all of the kernel, is called the *horny gluten.* Carefully shave it off with a sharp knife, then carefully remove the germ. Notice the size, position, and parts of the germ. The remainder of the kernel is starch, of which there are two kinds, the *horny starch* and the *white starch.* The horny starch lies on the back and sides of the kernel. The white starch occupies the crown end above the germ. Make an enlarged drawing of the kernel, showing and naming these parts.

5. **Preliminary study to corn scoring.** Each student should have an ear of corn, and tabulate in his notebook his observations on the ear, as follows:

	Ideal	Good	Fair	Poor
Shape of ear......................	.....	.....	.....	.....
Length of ear.....................	.....	.....	.....	.....
Circumference of ear..............	.....	.....	.....	.....
Tip of ear........................	.....	.....	.....	.....
Butt of ear.......................	.....	.....	.....	.....
Kernel uniformity.................	.....	.....	.....	.....
Kernel shape......................	.....	.....	.....	.....
Color in grain and cob............	.....	.....	.....	.....
Space between kernels at cob......	.....	.....	.....	.....
Space between rows................	.....	.....	.....	.....
Vitality or seed condition.........	.....	.....	.....	.....
Trueness to type..................	.....	.....	.....	.....
Proportion of shelled corn to cob..	.....	.....	.....	.....

Indicate with cross (X) opposite each point the column in which you would place the point.

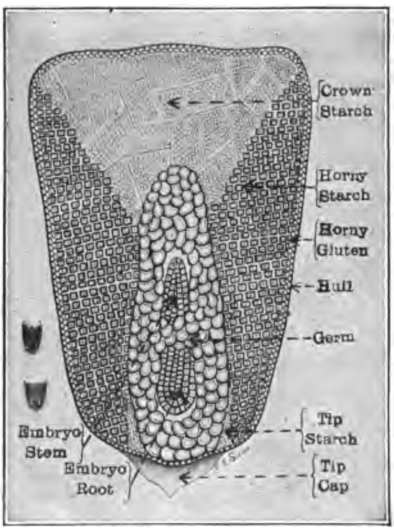

FIG. 15. STRUCTURE OF A KERNEL OF CORN

6. **Scoring practice.** Provide each pupil with ten acres of corn and let him practice scoring, using the score-card of

your state. Each pupil should score a half dozen or more ten-ear samples before this exercise is concluded.

8. **Rack for holding seed corn.** A simple, inexpensive, but very good method of caring for seed corn is described below:

Cut a piece of binding twine twelve feet long; tie the ends together, thus forming a loop. Place one end of the loop over the right and the other over the left hand, holding the hands about two feet apart and at such height that the middle of the strands just touches the floor. Place an ear of corn in the swing thus made, with the strands four or five inches apart under the ear.

When the first ear is in place, bring the left hand, with its strand, through the strings held in the right hand and on under to the elbow of the right arm, thus crossing the strings over the first ear. Then place the second ear in the crossed strings over the first ear; withdraw the left hand; the strings will then be crossed again ready for the third ear. Repeat this operation until the end of the string is reached; then loop the short end over the long one, leaving a loop by which to hang the string of corn. Let the pupils prepare a few strings of corn to hang in the schoolroom for Corn Day.

Another rack can be made of strips of lath as follows:

Get a bundle of plastering lath, and two boards about 4 feet long and 5 inches wide. Nail the lath strips opposite each other on the board, about 3 inches apart, so that when all are nailed on, the whole affair will stand supported by the boards as end pieces. The corn is then laid across from one lath to the other, thus securing free circulation of air about the ears, and allowing them to be easily handled.

9. **Testing seed corn.** Follow directions for testing seed corn given in the chapter, and practice testing at least a bushel of corn. At the proper season test the seed of the farmers of the community.

10. **Shrinkage in corn.** Procure ten ears of corn from

the field. Husk and weigh them. Record the weight and place them in a dry, safe place. Weight also ten ears of corn from last year's crop. Keep these also. Weigh both ten-ear samples at intervals of two weeks. Is there a change in the weights? Determine the loss of weight and the percentage of loss. This is the shrinkage

CHAPTER VIII

SOILS

"Population must increase rapidly, more rapidly than in former times, and ere long the most valuable of all arts will be the art of deriving a comfortable subsistence from the smallest area of soil."

—Abraham Lincoln

"It is not the land itself that constitutes the farmer's wealth, but it is in the constituents of the soil which serve for the nutrition of plants that this wealth directly consists."

—Liebig

SOIL PHYSICS

The soil a great natural resource. The few feet of soil covering the surface of the earth form the most important natural resource we have. The inscription carved over the entrance to the Agricultural Building of the University of Illinois—"The wealth of Illinois is in her soil, and her strength lies in its intelligent development"—is true for all the states of the Union. It is well, therefore, that we study the origin, nature, composition, and function of this valuable resource, to the end that it may be wisely used and permanently conserved for all the future generations. The careless observer is likely to think of the soil as merely dirt, and the unskilled farmer who dislikes his occupation often thinks of the soil only as a prison floor to which, perhaps, he is bound by chains of

debt and from which he must eke out a miserable existence. We should know at the outset that the soil is full of life and science, and that without it we could not be living in this world today. Most of our food, clothing, and shelter comes directly or indirectly from the soil.

Formation of the soil. We are so familiar with the soil as we see it that most of us do not stop to think that it was ever different. But it has really taken a long time for nature to form what we know as the soil, and in so doing she has employed wonderful agencies about which we shall write. If we were to examine a sample of soil with a strong magnifying glass, we would find that it is made up largely of fine particles of rock. Mixed with these particles in varying quantities are dark materials which are called organic matter, or sometimes humus. A closer examination will show that the organic matter is simply the remains of plants and animals which have formerly grown on the land, and which have partially decayed or rotted in the soil. We find, then, that the soil is composed of small particles of rocks mixed with the remains of former plants and animals, and that by far the larger part consists of these rock particles. This suggests the truth that the soil has been formed from the solid rocks, such as are found beneath it. Geologists tell us that at one time all the surface of the earth was solid rock; at that time there was nothing like what we now know as soil. These rocks contained all the elements necessary to make soil and furnish food for plants, with the exception of the elements, nitrogen, oxygen and carbon, which come from the air. Just as it is necessary for the miller to grind

the wheat to make it into food for man, so it became necessary for nature's forces to grind the rocks in order to prepare the food in them for plants. In other words, the first process in soil formation is the pulverization of rocks.

Several methods have been used to bring about the breaking up of the rocks. Among these is change of temperature, or heat and cold. The expansion and contraction of the rock particles due to heat and cold and the water content result in the breaking up of these rocks into small pieces. Another factor is the action of running water. Water running over stones gradually wears off the surface. Rapidly moving water carries pieces of stone along with it, and these rubbing together and over the surface of the stream bed help to break up the stones and make soil. There are also chemical influences of air and water in aiding these physical forces. Another agency which helps to grind rocks is moving ice in the form of glaciers. There is an accepted theory that at one time all the northern part of our country was covered with a thick sheet of ice. This immense glacier pushed its way down from Canada, carrying with it large quantities of rock, grinding them against each other until they were reduced to fine soil material. When the ice melted later, the rock particles were distributed and became the great glacier deposits upon which the soil was formed.

Soil produced by the mere grinding of rocks alone is not sufficient for crop production, however. The plant-food in this soil must be made available, that is soluble for plant roots to absorb. Water is important in bringing about this

change. Water which falls on the soil conducts carbonic acid gas from the air, and this helps dissolve quantities of the rock minerals. The oxygen of the air also helps to make plant-food available in the soil. Mineral matter alone, as we shall learn later, can not support plant life. A soil to be fertile must contain nitrogen. All the nitrogen in the soil came originally from the atmosphere. The air is four-fifths nitrogen, but it is in a form which most plants can not use. Before it can serve as a plant-food in the soil, it must be combined with oxygen and certain mineral elements in the soil in the form of a nitrate. A little of this is formed during electrical storms and is carried into the soil by the rain.

The growth of vegetation is a factor in soil formation. The vegetation began with the smallest forms, such as lichens and mosses. These die and become a part of the soil. The soil is soon able to produce larger plants and to add the residue of these plant growths to the soil in its formation. The plants upon decaying give rise to the organic matter, and this increases the fertility of the land, by being a source of plant-food and soil aeration, and by increasing the water-holding power. During the decomposition of the plants, acid substances are formed which act upon the rocks in such a way as to make more plant-food available. One of the products of this decay is carbonic acid gas. This gas is dissolved by the water and is an important factor in disintegrating the rocks. The roots of plants often penetrate the soil to great depths and exert tremendous force in breaking apart rocks and stones, if they once obtain a foothold in the crevices;

and after they decay they leave little channels in the soil which serve to carry down water laden with carbonic acid, as well as to introduce air that is a factor in bringing about chemical changes in the soil and in furthering work in soil formation.

We shall learn later that in the process of soil formation certain leguminous plants, such as clovers, vetches, etc., are introduced into the soil, and that upon the roots of these plants are nitrogen-gathering bacteria, enabling the plant to derive part of its food from the nitrogen of the atmosphere. The return of these plants to the soil through their decay adds the element of nitrogen in the further formation of soil. The soil is not only alive with bacteria, but myriads of forms of animal life live and burrow in the soil, and aid in soil formation.

The various agencies concerned in the formation of the soil do not act separately, nor necessarily in any particular order. As a matter of fact, all the processes take place simultaneously. Neither is all the soil formed directly from the original rock. The soil is almost constantly moving, for some of the agencies which form soil also carry it away. It is always moving from higher to lower levels. Consequently it is thinnest at the top of the hill and deepest in the valley. Nature undisturbed has many ways of adding to the supply of available plant-food in the soil. The various forces discussed have all tended to change the food into forms that can be assimilated by the plants. Man has reversed the process, and while adding little to the soil has removed much from it. A study of the formation of the soil suggests two things

that the farmer can do to prevent the wearing out of the soil: first, he can so treat the soil as to assist and hasten nature in the process of making plant-food; second, he can return to the soil an amount of plant-food equivalent to that removed by the crop.

Classification according to texture and structure. When the soil is formed by so many varied agencies as are enumerated above, it is clear that it will vary in fineness of texture according to the degree to which the rock material has been reduced. Some particles are so small that twenty-five thousand of them can be placed in a linear inch. It is impossible for the unaided eye to distinguish such small objects. From this extremely small size the particles range in size to small stones. Some soils are composed almost entirely of the smallest particles, while others are made up of coarser material. The size of the unit particle determines soil texture; the arrangement of these units determines soil structure. The fineness and arrangement of the rock particles, together with the kind of rock from which the soil was derived, influence greatly the producing power of the soils.

Soils may be classified, based upon size of the particles, into stony soil, gravelly soil, sand, silt, clay, and loams. The various grades of soil particles and amounts present, together with the amount of organic matter, give rise to the names of the common soil types; as, black clay loam, brown silt loam, gray silt loam, yellow silt loam, peat, peaty loam, sandy loam, etc. Reduction in size of particles increases the internal area or total area of all particles, thereby increasing the feeding area for the root hairs and

the power of the soil to hold and move moisture. The size and arrangement of the soil particles are of great importance in farming operations. Clay holds so much moisture because of its fine texture, and gives it up so slowly that farmers call such soils cold and heavy. A good soil should be a balanced mixture of these soil materials.

Soil water. We cannot think of soil without noting its close connection to the water it contains, or should contain. The function of water in the soil is to supply plant-food, to dissolve mineral, plant-food elements, and to carry them in solution by capillary attraction to the roots of the plants. There are three forms of water in the soil: first, the free or gravitational water; second, the capillary water; third, hygroscopic water. The gravitational water is the excessive water which we seek to remove by drainage. It seeks its level at the water table of the ground. The capillary water is the water adhering to soil particles and drawn by capillary attraction to the drier areas. It is the most important form of water for the use of the plant. Hygroscopic water is the water in the form of a very thin film about each particle of soil. This water can not be removed except at very high temperature, and it has little value, perhaps, in plant growth.

The presence of water in the soil is one of the controlling factors in crop production. The farmer may have some control over the water supply of the soil: he may increase the water content by incorporating in his soil more organic matter, thus decreasing loss by percolation; he may provide the soil mulch, preventing evaporation of the water from the soil; he may deepen the soil by cultivation, thus increasing

the water-holding capacity by preventing a larger amount from running off. The farmer may decrease the soil water by drainage, but at the same time increase the available water for his crop. The best control of soil water is seen in systems of irrigation and dry farming.

Soil air. A considerable amount of air is found in the interstices of all good, live soil. This air functions in supplying to the soil the elements of oxygen, nitrogen, and carbonic acid gas. It is not definitely known what the whole work of oxygen in the soil is, but we know that the roots of most economic plants must have oxygen about them or, like animals, they will die for want of this element. The bacteria of the soil, necessary in decomposing organic matter and in extracting nitrogen from the air for the legumes, must have an oxygen supply or else their processes do not continue. Carbonic acid gas functions in disintegrating the mineral elements for plant-food. The farmer may control to a certain extent the air of the soil. The incorporation of organic matter, the proper tillage, drainage, etc., open up the soil, making avenues for the movements of air which function as described above.

Soil temperature. It is a well known fact that the temperature of the soil must be congenial to the growth of plants adapted to that soil. The soil must have sufficient heat for the germination of the seed, for the growth of the roots, and for the activities of the soil bacteria. The temperature of the soil is affected by its color, slope, water content, evaporation, and organic matter. The way in which these things affect the soil temperature is evident. Dark colored soils are

warmer than the light colored ones. Southern and western slopes are warmer than northern and eastern. Water logged soil is colder than a dry soil. Soil well aërated by tillage, drainage, and organic content is warmer than the close, dead soil.

Active organic matter in the soil. By active organic matter we mean plant and animal substances in process of active decay. This is sometimes called humus, but we should understand humus to mean that organic matter which is in various stages of active decay from the more active stages to the carbonized inactive organic matter, such as coal. The decomposition of organic matter is carried on by various bacteria living and reproducing under favorable conditions upon the organic matter. Such organic matter, having larger surface than inorganic matter, increases the water content of the soil, provides aeration and makes the soil friable. The farmer may control the organic content of the soil, and this control is often the beginning of soil improvement and systems of permanent agriculture. He may incorporate in the soil the crop residues, all the animal manures available, and return to the soil most of the legume crops. These practices are all part of a good system of crop rotation.

Tillage of the soil. By tillage of the soil we mean all the handling of the soil usually included in the use of implements for plowing and preparation for plant growth. Tillage of the soil pulverizes it, and puts it into better physical condition for providing itself with the proper moisture. Soil that is too wet works at a disadvantage, as every farmer knows, causing an injury requiring a long time to correct.

Tillage opens up the soil to air and increases the water holding capacity. With the aëration of the soil, soil organisms mentioned above flourish and successfully reproduce, and these factors in turn render more plant-food available, thus increasing the growth of the plant. It is a well known fact that shallow cultivation prevents the escape of water by evaporation and is, therefore, a successful method of water conservation. Someone has said that weeds are a blessing to the farmer because in the cultivation of the soil to rid the land of weeds he brings about the results of cultivation mentioned above. Incidentally it may be noted that cultivation of the soil is a method of combatting many insect pests. This is especially true in the case of fall plowing, when the winter stages of certain insects may thus be exposed to the freezing weather.

With the development of the science of physics and of farm machinery, many new and efficient tools of cultivation are coming to the farm to bring improvement in the cultivation of the soil.

Soil organisms. In the discussion of physical conditions of the soil we must not lose sight of the more recent discoveries of the effects of soil organisms such as bacteria, insects, worms, and even rodents upon soil conditions. It has already been stated that the bacteria working in the decaying organic matter of the soil make possible that condition which we see in a rich, organic, loamy soil. Since these soil organisms are so essential both to soil physics and soil fertility, as we shall see later, it is necessary that the conditions affecting their growth be kept favorable—such condi-

tions as air, temperature, organic material, and freedom from acidity. These are problems in soil physics.

Effects of lime in the soil. We usually think of lime as relating to soil fertility, but we know that the application of lime to the soil has certain effects upon its physical condition. The application of lime to a sandy soil has a tendency to cement together the particles and give the soil more body,

FIG. 16. A LIME SPREADER.

improving its structure and tillage. The application of lime to stiff clay soils or clay loams tends to flocculate the finer particles and open up the soil, giving it more air, making it more friable, and more easily drained.

Soil Fertility

The idea to be kept constantly before the student of agriculture and the farmer is the wise use of the natural resources

resulting in their conservation. A study of soil fertility, therefore, must keep constantly before us the theme of conservation—wisely using and making permanent the fertility of the soil for all future use. To restore a depleted soil to high productive power in economic systems of agriculture requires education and skill.

Elements of plant-food. The farmer should be as familiar with the names of the ten essential elements of plant-food as he is with the names of his ten nearest neighbors. These plant-food elements are just as necessary for the plant as food is for animals. Agricultural plants consist of ten elements. Not a kernel of corn, grain of wheat, leaf of clover, or spear of grass could be produced if the plant failed to secure any one of these ten elements. Some of them are supplied in abundance by natural processes; others are not so provided, and the farmer must supply them or his land becomes unproductive.

The ten elements that plants live on are carbon, hydrogen, oxygen, phosphorus, potassium, nitrogen, sulphur, calcium, iron, and magnesium. Two elements, carbon and oxygen, are contained in the air in the form of a gas called carbon dioxide, and this compound is taken into the plant through the thousands of breathing pores upon the leaves. Hydrogen is one of the elements of which water is composed. Water is taken into the plant through the roots, carried through the stem to the leaves, and there, under the influence of chlorophyll, sunlight, and life-principle, the carbon, oxygen, and hydrogen are made to unite into important plant compounds, such as the sugars, later transformed into starch and fiber.

Oxygen exists in the air as a free element, is taken in by respiration through the leaves of the plant, and functions in a similar way as it does in the animal body.

Carbon, oxygen and hydrogen constitute the largest part of the agricultural plant, but plant growth is not possible without seven other elements supplied by the soil. Iron is one of the essential elements of plant-foods, but the amount required is small and the amount contained in the soil is large. Sulphur is found in plants in small amounts and is essential to plant growth. The supply of sulphur in normal soils is not large, but with the decay of organic matter a great deal of sulphur passes into the air and is brought back to the soil, dissolved in rain. Under normal conditions the sulphur supply is ample to meet the needs of the farm crops.

There are five other essential elements of plant-food that require special consideration in connection with permanent soil fertility. They are nitrogen, phosphorus, calcium, magnesium, and potassium. In studying these five elements we must note the following points: the soil's supply, the crop requirements, the loss by leaching, the methods of liberation, and the means of renewal. The neglect of one or more of these points will reduce the fertility of cultivated soils and bring about conditions that are well known in the impoverished older farm lands of the United States. Intelligent attention to these factors will restore and make productive such lands.

Fertility in normal soils. Of the important mineral elements potassium is the most abundant in common soils. Doctor Cyril G. Hopkins of Illinois states that in an average of

ten residual soils from ten different geological formations in the eastern part of the United States, two million pounds of surface soil were found to contain:

Potassium	37,860	pounds
Magnesium	14,080	"
Calcium	1,810	"
Phosphorus	1,100	"

He further states that in the common type of the great soil area of Illinois' corn belt, two million pounds of the surface soil contain as an average:

Potassium	36,250	pounds
Magnesium	8,790	"
Calcium	11,450	"
Phosphorus	1,190	"

In the older clay silt loam soil of southern Illinois, he states the content for the same number of pounds to be:

Potassium	24,940	pounds
Magnesium	4,680	"
Calcium	3,420	"
Phosphorus	840	"

It will be seen by these figures that these soils are rich in potassium and poor in phosphorus. These figures bear some relation to the composition of the earth's crust, which contains in two million pounds, 49,200 pounds of potassium and 2,200 pounds of phosphorus.

Plant-food required for crop growth. Quotations from Bulletin No. 123 of the Illinois Experiment Station give the following interesting data:

——Produce—— Kind and amount	Nitrogen	Phosphorus	Potassium
Corn, grain (100 bu.)	100	17	19
Corn, stover (3 T.)	48	6	52
Oats, grain (100 bu.)	66	11	16
Oats, straw (2½ T.)	31	5	52
Wheat, grain (50 bu.)	71	12	13
Wheat, straw (2½ T.)	25	4	45
Timothy hay (3 T.)	72	9	71
Clover, seed (4 bu.)	7	2	3
Clover, hay (4 T.)	160	20	120
Alfalfa (8 T.)	400	36	192
Apples (600 lbs.)	47	5	57
Potatoes (300 bu.)	63	13	90
Fat cattle (1,000 lbs.)	25	7	1
Fat hogs (1,000 lbs.)	18	3	1
Milk (10,000 lbs.)	57	7	12
Butter (500 lbs.)	1	.2	.1

The value of the elements may be computed on the basis of a common market price for available plant-food, as follows:

Nitrogen	15 cents per lb.
Phosphorus	12 " " "
Potassium	6 " " "

The plant-food required for one acre of wheat yielding 50 bushels, one acre each of corn and oats yielding 100 bushels, and one acre of clover yielding 4 tons, is the total crop need of:

Potassium	320 pounds
Magnesium	68 "
Calcium	168 "
Phosphorus	77 "

From these figures one may estimate the cost of fertilizers in maximum crop production.

Liberation of soil fertility. After determining the total amount of plant-food in a plot of soil, the next important question is not how much is available, but how much can be made available during the course of the crop season year after year. We must liberate plant-food by practical methods. We must convert it from insoluble compounds into soluble and usable forms, for the plant-food must be made soluble before the plant can take it from the soil. It has already been stated in previous paragraphs that decaying organic matter is the important factor in making plant-food available, and attention has been called to the fact that the decomposition of this organic matter is hastened by drainage and tillage, which permit the air to enter the soil and assist in the decomposition of the organic material. The application of limestone, as will be explained later, also assists in the liberation of certain plant-foods.

Loss of plant-food. These plant-food elements are lost by cropping, erosion, and leaching. In a four-year crop rotation under ordinary practices, the amount per acre of calcium lost by leaching is 300 pounds; of magnesium, 30 pounds; of phosphorus, 2 pounds; of potassium, 10. It is a well known fact that great quantities of our richest soil are washed from the hillsides and valleys into the streams and carried to the sea. Some of the richest of the corn belt soils have found their way to help build the delta at the mouth of the Mississippi. The table above gives some idea of the extent to which the plant-food of the soil is lost through removal of crops that are grown upon the soil.

Sources of elements likely to become deficient. It was

noted above that nitrogen, phosphorus, potassium, and probably calcium and magnesium, were the elements likely to become deficient. This being true, we must look to sources from which these elements may be economically obtained, and maintain if possible and even increase the fertility and productive capacity of the soils. Some sources from which these elements may be obtained are crop residues, barnyard manures, legumes, commercial fertilizers, and mineral supplies.

Crop residue. All the material which makes up the roots, stubble, leaves, and other residue left after removing the crop, contains plant-food elements derived from the soil and air. To remove this residue or to burn it would be an evident loss of soil fertility. Should these residues be returned, their decomposition would not only add the elements to the soil in large measure, but the organic material which they would supply would give greater water-holding capacity to the soil, raise its temperature, foster the growth of bacteria, and promote better physical condition.

Legumes. Every school boy knows that upon the roots of the legumes such as red clover, sweet clover, alfalfa, soy beans, cow-peas, vetch, etc., are growing nodules which are colonies of bacteria living upon the roots of these plants, drawing the free nitrogen from the air and making it over into an available form for the plant. This nitrogen is assimilated into the leaf, stem, root, and seed of the plant. About as much nitrogen is contained in the part of clover above ground as is taken from the air. It will be seen, then, that if these legume plants be plowed under and incorporated

in the soil, large amounts of nitrogen will be supplied to the soil. In addition to this value, the mass of material making up the legume crop will add to the organic matter of the soil and give all the values ascribed above.

Organic matter and its relation to soil fertility. When barnyard manures, crop residues, legume crops, or any other organic matter are incorporated in the soil and the physical conditions are right, the decay of this organic matter liberates directly plant-food elements, helps to dissolve certain mineral elements such as phosphorus and potassium, and makes them available as plant-food. The organic content of the soil provides a more suitable home for the growth of bacteria, which are important factors in soil fertility.

It must be noted in this connection that barnyard manure, in addition to furnishing excellent organic matter, is also a source of plant-food. Ordinary barnyard manure contains per ton 10 pounds of nitrogen, 2 of phosphorus, 8 of potassium, with a value of $2.22 per ton for the plant-food elements. We may see from these figures that it would take a very great amount of barnyard manure to maintain permanently the fertility of the soil under maximum crop production, as is also shown in the paragraph above on plant-food required for crop growth.

Nitrogen. Nitrogen is one of the most abundant elements in nature, yet it is the most costly element to the farmer as a plant-food. Some important facts regarding nitrogen emphasize its value to the farmer:

a. All growing plants require nitrogen.

b. Plants can get nitrogen only as a compound from the soil.

c. Nitrogen is a free gas in the air.

d. There are about seventy million pounds of nitrogen over each acre.

e. Nitrogen in the combined form is unstable and easily lost.

f. The nitrogen supply in most soils is low.

g. Nitrogen compounds in the soil are mainly in organic matter and extend only a few inches below the surface.

h. Nitrogen is the one element of plant-food that is most easily lost and wasted, and is often the limiting element in maximum crop production.

i. The growing crops draw heavily upon the nitrogen supply in the soil.

j. If it were possible to exhaust the supply in the average soil, it would be entirely used up by thirty-two 100-bushel crops of corn.

k. Considerable nitrogen is lost by percolation of drainage water.

l. Many nitrogen compounds are easily lost by leaching.

Nitrogen is obtained for agricultural purposes from the following sources: rainfall, snowfall, and electrical storms; bacteria are the natural means by which nitrogen is supplied to the soil. Fish, blood, tankage, cottonseed, sodium nitrate, calcium nitrate, and ammonium sulphate are commercial forms of nitrogen. Farm manure, green manures, such as inoculated legumes and crop residues, are the natural economic

methods of maintaining and increasing soil nitrogen in general farming.

The chief value of farm manure, aside from its supplying organic matter, is its source of nitrogen supply, but, as was noted above, it is impracticable under the present production of live stock to look to this source for an adequate supply of nitrogen. A more interesting and economic source is the green manure from inoculated legumes. One ton of red clover, when plowed into the average normal soil, will enrich the soil by the addition of forty pounds of nitrogen, and is, therefore, equal in nitrogen value to four tons of barnyard manure. The use of red clover, alfalfa, cow-peas, soy beans, sweet clover, and other legumes provides the greatest soil improvers, and has made possible a permanent economic system of soil improvement. The use of high-priced commercial nitrogen is artificial and unprofitable in general farming operations.

A system of crop rotation that does not include a legume crop which may be incorporated into the soil to furnish the organic matter and the nitrogen supply is not a part of a permanent system of soil improvement.

Phosphorus. Doctor Hopkins calls phosphorus the master-key to permanent agriculture. He says that phosphorus is really what its name signifies—light-bringer; but that it is a light which the American farmer has not seen. We have exported to Europe each year enough phosphorus to double the average crop production of the entire United States, if it were all wisely used on our soils. The tables given in a previous paragraph show that ordinary soils are defi-

cient in phosphorus, and the results of many experiments in the United States and in England have shown that the application of phosphorus in good systems of farming produces marked and profitable increases in crop yields.

The important question is what form of phosphorus we shall apply. There are many kinds of fertilizing materials containing phosphorus, and one may cost many times as much as another. For example, 280 pounds of phosphorus in a ton of finely ground natural rock phosphate may be purchased at the mines in Tennessee and delivered at the farmer's railroad station in the central states for about $12. Or, the ton of raw phosphate may be mixed with a ton of sulphuric acid in the factory, and the two tons of acid phosphate may be sold to the farmer for $60. Again, the fertilizer manufacturer may mix two tons of acid phosphate with two tons of filler containing a little nitrogen and potassium, and then sell the four tons of complete fertilizer for $160. And the farmer gets only as much phosphorus in the complete fertilizer for $160 as he would get in the one ton of natural phosphate for $12.

Common sources of phosphorus are raw bone, steamed bone, raw rock phosphate, acid phosphate, and basic slag. The next important question for consideration is the problem of making the phosphorus available as it appears in these various sources.

When the natural rock is used, it should be ground so that at least 90 per cent will pass through a sieve with ten thousand meshes to the square inch, and a content of from 12 to 15 per cent of phosphorus should also be guaranteed.

Twelve to 15 per cent of phosphorus in rock phosphate is equivalent to the 28 and 34 per cent of the so-called phosphoric acid. It must also be said, in advising the use of the natural rock, that it must be used liberally and in connection with plenty of decaying organic matter. The phosphorus in the raw rock must be made available, and this is done through the decomposition of organic matter. About one ton of rock phosphate once every four or five years incorporated in the soil with a green manure crop or barnyard manure is the economic way of using this mineral plant-food. As was said before, in the decomposition of these organic materials, carbonic acid and possibly other acids are formed, and these furnish a solvent for the phosphorus compound in the natural rock.

Other forms of phosphorus, such as raw bone, steamed bone, and acid phosphate, are more quickly available than the rock phosphate and give quicker results when used, but they are more expensive when purchased in sufficient quantity to supply the need. These soluble forms of phosphorus may be practical and economical in truck farming, gardening, and in starting such crops as alfalfa and other legumes.

Potassium. The tables given in a preceding paragraph show that potassium is an abundant element in normal soils. It is found in greater abundance in clay soils than in sandy or peat soils. As it exists in clay soils it is often unavailable and must be made soluble for the plants' use by proper tillage and by the use of organic matter. By the use of active organic matter, as explained above, large quantities of potassium otherwise not available are made available to

the plant through the decomposition of the organic matter. Barnyard manure serves in this way in addition to other more direct benefits. In a peaty swamp soil or bog land, it has been found that the potassium content is often very deficient, and that its deficiency is a limiting element in the production of crops.

The commercial sources of potassium are kainit, potassium sulphate, potassium chloride, wood ashes, and manure.

It would seem, therefore, that in systems of general farming it would not be necessary to apply commercial forms of potassium, but to utilize the supply already found in abundance in the soil. Sometimes, however, in getting legumes started, and in building up worn out land, it may be necessary to make an application of some form of potassium such as kainit, in order to furnish food which is quickly available for the young plant. In truck and garden farming where intensive methods are used, applications of potassium are often profitable.

Limestone. We must not omit mentioning limestone as a factor in soil fertility. Its first chemical effect is to neutralize the excessive acidity which prevents the growth of legumes. Often the first step, therefore, in renewing a soil is to correct the acidity, making it possible for the legumes to grow so that organic matter may be incorporated into the soil, thus furnishing a basis upon which to build the nitrogen and mineral plant-food supplies. Certain plants require large amounts of calcium as a plant-food, such as clover, alfalfa, and blue grass. Lime has been used as a fertilizer for thousands of years. It has been used in three forms: the ground

limestone or calcium carbonate, the burned lime or calcium oxide, and the hydrated lime or calcium hydroxide. Recent practices have justified the conclusion that ground limestone may be applied in any amount with no injurious results, while caustic lime destroys the organic matter, dissipates the soil nitrogen, is disagreeable to handle, and may injure the crop. If dolomitic limestone is used, magnesium as well as calcium is thus added to the soil. Limestone need not be very finely pulverized. If ground so that it will pass through a ten-mesh sieve, it is fine enough, and the coarser and finer material may be profitably mixed together in the application.

Limestone is easily soluble in soil water carrying carbonic acid. It is thus readily available, and in humid sections the loss by leaching is great. About two tons an acre of ground limestone should be applied every four years when necessary in economic systems of farming. There are now on the market special spreaders to use in the application of fine ground raw rock phosphate and the pulverized limestone.

The following record of a crop rotation and the application of rock phosphate and limestone in a system of permanent agriculture is an account of an actual farm in southern Illinois which had been agriculturally abandoned for five years previous because of its inability to produce profitable crops with ordinary methods of farming. This outline carefully studied will give the student and the practical farmer the correct idea of permanent systems of soil fertility, and what is meant by conservation of soil resources.

The farm under consideration consisted of about 300 acres of poor, gray prairie land and was purchased in November,

1903, for $15 an acre. It was known in the community as the "Poorland Farm." The work of restoration was begun on 40 acres of the farm, which were covered with a growth of red sorrel, poverty grass, and weeds. The land was sour, dead, and depleted of plant-food. During the ten years following the purchase of the farm the 40 acres received the following treatment:

1903	Fall	Applied one ton per acre—fine ground rock phosphate
1903	"	Plowed for corn for next year
1904	Spring and Summer	Crop of corn
1904	Fall	Applied limestone, two tons per acre
1905	Spring	Crop of soy beans
1905	Fall	Crop of wheat
1906	Spring	Clover sowed in wheat
1907	"	Timothy and more clover
1908		Meadow and pasture
1909		Meadow and pasture
1909	Fall	Applied rock phosphate
1909	"	Plowed for corn
1910	Spring and Summer	Crop of corn
1911	Spring	Oats—volunteer clover appeared
1912	Spring and Summer	Clover harvested
1912	Fall	Plowed for wheat
1912	"	Applied limestone—two tons per acre
1912	Summer	Wheat harvest

Six loads per acre of barnyard manure were applied once during the ten years. Only 39 acres were in wheat, a lane having been fenced off on one side of the field. The yields were as follows:

1½ acres, with farm manure only, 11½ bushels per acre.
1½ acres, with farm manure and one application of ground limestone, 15 bushels per acre.
36 acres, with farm manure, two applications of ground limestone and two of fine ground phosphate, in the rotation as described above, 35½ bushels per acre.

FIG. 17. EXHIBIT SHOWING THE VALUE OF LIME AND PHOSPHATE

Here we have a yield of wheat about double that of the average land of the state. The practical farmer will naturally ask, "What did all this cost?" The average annual

cost for the purchase, delivery, and application of the limestone and phosphate was $1.75 per acre. In the ten years, then, the total cost was $17.50 per acre. Add to this the original cost, $15 per acre, making $32.50, and still you have pretty cheap land to produce double the average of the state. Doctor Hopkins puts it this way: "The average annual investment of $1.75 resulted in an increase of 24 bushels of wheat (35½—11½) per acre. Thus we may say that the application of these two natural rocks, or stones, brought about the production in 1913 of 864 bushels of wheat, an amount sufficient to furnish a year's supply of bread for more than a hundred people."

This story of the Poorland Farm is a remarkable instance of the conservation of one of our greatest resources, the soil. Conservation means a saving of the resource by a wise use of it. At the end of ten years of use the soil on the "Poorland Farm" is producing more wheat than the average production of the state, and at the same time its fertility is increasing year by year.

Summary of facts on soil fertility. In the following paragraphs the basic facts of the Illinois system of permanent fertility are summarized. These should be thoroughly understood and become the ready knowledge of every student of agriculture.

All agricultural plants are made of ten elements, five of which are always provided by nature in abundance, carbon and oxygen taken from the air, hydrogen from water, and iron and sulphur from the soil. Man need not concern himself about these five elements. His fertility problem is thus

at once reduced to a consideration of the other elements, nitrogen, potassium, phosphorus, calcium, and magnesium.

The Illinois system of permanent soil fertility recognizes that there is an inexhaustible supply of nitrogen in the air, and provides for its utilization as needed; also that there is an inexhaustible supply of potassium in the soil which may also be liberated and utilized as needed. It also recognizes that the supply of phosphorus in the common Illinois soil is very limited, that phosphorus is contained neither in the air nor in the rain, and consequently that phosphorus must be purchased and applied to the soil in larger amounts than are removed in crops if the productive power of the soil is to be increased and permanently maintained. The Illinois system also recognizes that soils should be sweet, not acid or sour, and that ground limestone will destroy acidity and also provide calcium, which is sometimes deficient; and, finally, that if magnesium is also deficient in the soil, which is rarely the case, it, too, may be provided, together with calcium, in dolomitic limestone, which is the most common limestone of northern Illinois, and which consists of the double carbonate of calcium and magnesium.

These are the simple basic facts which every man should make a part of his ready knowledge, and then proceed to make use of in his farm practice.

There is no one order of procedure that is best under all conditions, and the step which should be taken first in one season may not be best in another season. However, these are minor matters, the same as the time of plowing, the time

of planting corn, and the question of threshing from the stack or after stacking.

One method of procedure in the beginning of a system of permanent soil fertility is to spread one ton of finely ground rock phosphate per acre on pasture land or clover meadow and plow it under; then apply two to four tons of limestone per acre, mix it with the soil in preparing the seed-bed, sowing wheat in the fall and clover the next spring; or apply rock phosphate where manure has been spread, and plow both under for corn; then apply the limestone before planting the corn. Both phosphate and limestone are then in the soil ready to benefit oats and clover which may follow the next year after corn.

After the first rotation, half of these quantities of fertilizer once every four or five years is sufficient to maintain permanently the supply of both limestone and phosphorus. While limestone and phosphate, when properly used, increase the yields of wheat, oats, and corn, their most important use in permanent agriculture is to make possible the production of large yields of clover and other legumes which may be returned to the soil in large part, either with crop residue or in farm manure, in order to provide both nitrogen and organic matter, and thus complete a system of permanent soil fertility. Benefits are also insured from the physical improvement of the soil which is brought about by the addition both of organic matter and of limestone.

The important question remains, how much clover or manure must be returned to the soil to maintain the supply

of nitrogen. To replace the nitrogen carried away in a 60-bushel crop of corn would require nine tons of manure or two and a quarter tons of clover per acre. The important thing is to use the facts concerning the amount of nitrogen in manure and crops, and return enough to the soil to provide for the grain crops, having such yields as are desirable or possible under permanent systems. The following facts should help us to solve this problem:

Nitrogen Supplies and Requirements

	Manure and produce	Nitrogen
1	ton average manure	10 pounds
1	ton clover hay	40 "
1	ton alfalfa hay	50 "
100	bu. corn	100 "
3	tons corn stalks	48 "
100	bu. oats	66 "
2½	tons oat straw	31 "
50	bu. wheat	71 "
2½	tons wheat straw	25 "

On Live-Stock Farms

For the live-stock farmer I would suggest a five-field rotation system besides the pasture land. Four of these fields may be used for a four-year rotation of corn, oats, and clover, while the fifth field grows alfalfa for perhaps five years, after which the alfalfa field may be put into the four-year rotation, and one of the other fields used for alfalfa for another five-year period, and so on. If the manure is saved with reasonable care, as many tons should be returned to the soil as the number of tons of air-dry produce that are

hauled off. It may be assumed that the roots and stubble of the clover and alfalfa contain no more nitrogen than was furnished by the soil for those crops, but that the nitrogen contained in the hay harvested may represent new nitrogen taken from the air. With the information thus far secured this is a reasonable basis to figure on for soils of moderate productive power.

For the grain and hay farmer this rotation may well be modified by substituting wheat for the first corn crop, thus growing wheat, corn, oats, and clover in the four-year rotation, and alfalfa on the fifth field. If only the grain, clover seed, and the alfalfa hay are sold, all stalks, straw, and clover (except the seed) being returned to the land, the nitrogen and organic matter may be maintained by the grain and hay farmer, provided a cover crop of clover is also seeded on the wheat ground in the spring to be plowed under late in the following fall or sufficiently early the next spring so as to get the land in good shape for corn.

Where there is no permanent pasture land, the live-stock farmer may seed both clover and timothy with the oats, and then use the field two or three years for meadow and pasture, thus making a six-field or seven-field system. With some modifications, a system of mixed farming may be practiced in which some crops are sold and others fed to live stock.

Notebook Questions

1. Why is the soil our greatest natural resource?
2. List the agencies active in the formation of the soil.

3. What are the types of soil of your local community?

4. Show how water may be a limiting factor in the production of the maximum crops.

5. What is meant by active organic matter in the soil?

6. Give some values of cultivation of soil.

7. What is meant by a live soil?

8. Name the ten plant-food elements and give their common source.

9. Which elements are most abundant and which are likely to be deficient?

10. What farm crops are the heaviest feeders on soil fertility?

11. What is meant by available plant-food in the soil?

12. How is plant-food lost from the soil?

13. What is meant by green manure, and what is its value?

14. Mention all the values of organic matter in soil fertility.

15. What are the most economic sources of nitrogen, phosphorus, and calcium in systems of permanent soil fertility?

16. Compare the cost of commercial forms of nitrogen with the natural source in legume crops.

17. Compare the cost of acid phosphate with raw rock phosphate.

18. What is meant by complete fertilizer?

19. Explain why the Poorland Farm mentioned in the preceding chapter was poor land. What were the essential steps in restoring this farm? (The answer to this question should be an explanation of a system of permanent soil fertility.)

20. (a) To produce 100 pounds of grain requires about 3 pounds of nitrogen, of which 2 pounds are deposited in the grain itself and 1 pound in the straw or stalks.

(b) In live-stock farming one-fourth of the nitrogen in the food consumed is retained in the animal products—meat,

milk, wool, and so on—and three-fourths may be returned to the land in the excrements if saved without loss.

(c) When grown on soils of normal productive capacity, legumes secure about two-thirds of their total nitrogen from the air and one-third from the soil.

(d) Clover and other biennial or perennial legumes have about two-thirds of their total nitrogen in the tops and one-third in the roots, while the roots of cow-peas and other annual legumes contain only about one-tenth of their total nitrogen.

(e) Hay made from our common legumes contains about 40 pounds of nitrogen per ton.

(f) Average farm manure contains 10 pounds of nitrogen per ton.

Question: How many tons of average farm manure must be applied to a 40-acre field in order to provide as much nitrogen as would be added to the soil by plowing under 2½ tons of clover per acre? Answer—400 tons.

Practical Exercises and Home Projects

1. **Field trip study of soil formation.** Early in the study of soils the instructor should take the class to places previously noted where there are good examples of soil formation by weathering, by plant action, by animals, and by other agencies discussed in the chapter. Require the pupils to take notes on observations made.

2. **Comparison of surface soil and subsoil.** Go to a field and get three soil samples as follows:

(a) Scrape away the plant growth and surface trash, take a sample of soil just below this, and seal it air-tight in a small jar.

(b) Dig or bore down to a depth of six inches and take another sample of soil.

(c) Secure a third sample from a depth of twelve inches from the surface.

Return to the laboratory and weigh out four ounces of each sample of soil. Spread each sample in a shallow pan and allow to dry for two or more days. Weigh each sample again. The difference between these weights and the first ones is the amount of water in the soils removed by evaporation. Note the color of each sample of soil. Examine with hand lens to see the size of soil particles. Heat each sample in an iron spoon until everything that will burn has been burned, and weigh each sample again. The difference between these weights and the last ones shows approximately the amount of organic matter in each. The last weights show the amounts of mineral matter in the soil samples. Tabulate the results as follows:

Depth of soil	Color	Amount of moisture	Amount of organic matter	Amount of mineral matter	Size of soil particles	Type of soil
1 inch.......						
6 inches.....						
12 inches.....						

Repeat this exercise with samples from different fields.

3. **Physical examination of soil particles.** Pulverize air-dry samples of sand, loam, clay, and gravel. Place a few grains of each sample of soil on a white paper and examine with hand lens. Tabulate your observations as follows:

Soil type	Color—White, gray, brown, black	Shape—Angular or round	Condition—Single or compound particles	Size—Coarse, medium or fine
Sand				
Loam				
Clay				
Gravel				

4. **Soil studies for water content.** Go to the field and with an augur take samples of surface soil, subsurface, and subsoil. Cover the samples in air-tight fruit jars, and take to the laboratory for further study. To determine the amount of capillary water in the soils, weigh the soil when taken, and after it is thoroughly air-dried weigh again. Note the difference as to capillary water. To determine the hygroscopic water, use the air-dried samples above obtained, note the weight made, then submit the soil to a temperature of 212° F. This drives off all hygroscopic water. Weigh again, and the difference should indicate the amount of this form of water.

5. **Determination of volume, weight, and specific gravity of soils.** Procure a given volume of soil. Weigh and determine specific gravity by methods common in physical laboratory.

6. **Capillary rise of water.** Fill glass tubes, preferably three feet in length and an inch or two in diameter, with air-dried soil representing as many different types as are available, such as sand, clay, loam, etc. Tie a cloth over the lower

end of each tube and fill with soil. Fasten the tubes with one end lowered in a vessel of water. Note from hour to hour the first day, and for twenty-four-hour periods afterwards, the rate and height of the rise of water in each type of soil.

7. **Water-holding capacity of different soils.** Fill tubes similar to the ones given in the preceding exercise with the same types of soil, and weigh the soil in each tube. Support the tubes so that water may be poured at the top and be permitted to percolate through the soil. As soon as the water begins to drip through the soils, cease pouring water upon them and after the dripping has stopped weigh the tubes to determine the amount of water held in the soils. This exercise will also show variations in the rate of percolation of water through the different types of soil. These facts should be noted, also, in recording the results of this exercise.

8. **Effect of the soil mulch.** Fill two vessels with equal weights of the same kind of moist soil. Stir the surface of one, and leave the other with the surface the same. Continue stirring the surface from day to day and note the difference in the weights of the two vessels. Explain the result of this exercise.

9. **Effects of lime on physical condition.** Make up a clay mud-ball mixed with ordinary rain water, and a second ball mixed with saturated limewater. Place the two balls aside for two days. Note the difference with which the two balls may be crumbled. Explain.

10. **Effect of manures on physical condition of soil.** Put some finely-screened clay in each of two pans. Pour the same amount of water into each pan and stir each until you have a thick, well-mixed mass. Into one pan mix thoroughly a handful of well-rotted manure or leaf-mould. Set both pans aside for the soil to dry. Which dries first? Why? When

thoroughly dry, crush the soil in each pan. Note the hardness of each soil. Write two sentences on the value of manures or other organic matter to a soil.

11. **Observational study of the plant-food elements.** Have samples of some form of the ten plant-food elements described in the chapter for observational work in these studies.

12. **Testing soils for acidity.** Bring in samples of soil from the various homes of the community to test for acidity. Cover a bit of blue litmus paper with moist soil, and after ten minutes examine the litmus paper. If it has turned red, it is an indication that the soil is acid. If hydrochloric acid be poured upon the soil and it effervesces, it is an indication that carbonates are present and that the soil does not need limestone to correct the acidity.

13. **Soil drainage demonstration.** There is on the market now a very practical and simple piece of equipment called the soil drainage apparatus which should be used in this exercise to demonstrate the principles of drainage and to illustrate the process. Directions will not be given here, for they accompany the apparatus when purchased.

14. **Simple soil tests for nitrogen.** To tell accurately the amount of nitrogen in soil requires elaborate equipment, but the following method will answer for practical purposes and does not require much apparatus.

In a clean glass vessel which can be heated place two tablespoonfuls of the soil to be tested. Add fifteen tablespoonfuls of ten per cent caustic potash solution. In another vessel add fifteen tablespoonfuls of water to two tablespoonfuls of soil. This is the control. Heat both samples to the boiling point, and set them aside for five minutes. If at the end of that time the solution which contains the caustic potash is black and opaque, the soil is rich in nitrogen. If it is merely dark and allows light to pass through it, the nitrogen content

of the soil is low. If the solution is yellowish, there is practically no nitrogen content. Compare the sample containing only water with the one containing the caustic potash. Test several samples of soil by this method, and record results as follows:

Soil samples	Nitrogen content high	Nitrogen content medium	Nitrogen content low
1...............			
2...............			
3...............			

15. **Pot cultures of community soils.** In order to determine the limiting plant-food elements in the soils of the locality, the pot culture method is a practical one to use. As many different systems of pots may be employed as there are farmers represented by members of the class. For each soil type to be studied secure ten four-gallon earthen jars. Fill each jar with the same kind of soil, taken from the field to be tested. Make sure that there is drainage from the bottom of the jar. Treat the soil in each jar as follows:

Jar No. 1—Nothing.
" " 2—Lime (hydrated), 12.5 grams. Well rotted barnyard manure (a sufficient amount worked into the soil to cover the surface about two or three inches).
" " 3—Lime; nitrogen (dried blood, 15 grams).
" " 4—Lime; phosphorus (bone-meal, 6 grams).
" " 5—Lime; potassium (potassium sulphate, 3 grams).
" " 6—Lime; nitrogen; phosphorus.
" " 7—Lime; nitrogen; potassium.
" " 8—Lime; phosphorus; potassium.
" " 9—Lime; nitrogen; phosphorus; potassium.
" " 10—Virgin soil, untreated.

Use the same amounts and forms for the lime, nitrogen, phosphorus, and potassium in each application given above as directed in jars Nos. 2, 3, 4 and 5. The best way to incorporate these fertilizers in the soil is to apply them in the form of solution.

Sow in each pot equal amounts of wheat or oats, and give the samples the same care and attention regarding light, temperature, and moisture. Note the growth of the plant from week to week. The growth of the plant should indicate the limiting plant-food element in the type of soil under observation. Record fully this experiment in the notebook.

16. **Outdoor plot experiments with various fertilizers in methods of soil improvement.** For a demonstration plot at the school, the following plan is feasible, providing labor is available and a long time policy of management is possible.

Arrangement and Numbering of Plots

10	11	12	13	14	15
20	21	22	23	24	25
30	31	32	33	34	35
40	41	42	43	44	45

General suggestions: Every boundary line should be a grass or gravel walk three feet wide. Every square should be 18 by 18 feet. Before harvesting crops, for records, each plot or square should be cut to a perfect rod square. For yield per acre, multiply by 160.

Rotations should be conducted as follows:

Plots 10, 11, 12, 13, 14, 15—Continuous corn crops.
" 20, 21, 22, 23, 24, 25—Corn and oats rotation.
" 30, 31, 32, 33, 34, 35—Corn, oats and clover rotation.
" 40, 41, 42, 43, 44, 45—Corn, oats, clover and wheat rotation.

The experiments in the value of standard fertilizers could be tested in this way:

Plots 10, 20, 30, 40—Nothing.
" 11, 21, 31, 41—Apply farm manure (rate 3 or 4 tons per acre).
" 12, 22, 32, 42—Manure and lime (lime, 2 tons per acre).
" 13, 23, 33, 43—Manure, lime and phosphorus (phosphorus, 1 ton per acre).
" 14, 24, 34, 44—Manure, lime, phosphorus, and potassium (kainit, 400 lbs. per acre).
" 15, 25, 35, 45—Nothing, and remove all vegetable matter before it decays.

Complete records of the treatment of the soil and of crop yields, together with an accurate map of the plots, should be kept.

PART II

ANIMAL HUSBANDRY

CHAPTER IX

FARM ANIMALS AND LIVE-STOCK FARMING

Live-stock farming. So important are farm animals in agriculture that whole systems of farming are built about the live-stock interests. Without discussing the comparative merits of live-stock farming and grain farming, we must all agree that the raising of live stock on any farm has its advantages both to the farm and to the public good. Since the decrease of live stock on the great ranges of the West, and since general farmers have commonly stopped raising cattle because they were unable to compete with the production of the range, the raising of live stock has decreased in the United States until in the last decade we have had an 8 per cent decrease of live stock and a 25 per cent increase of our population. As a public question, therefore, it is of prime importance that the farms of the country begin the business of raising more live stock. This would, furthermore, work to the advantage of the individual farmer. The raising of live stock on the farm enables farmers to utilize profitably much material that would otherwise be of little value. Moreover, by feeding his fodder and grain to animals he can get much more than

by selling them directly. Besides this the waste materials are returned to the soil as fertilizer. Another value of live stock on the farm which must be noted is the satisfaction and pride which the business gives to the farmer, especially if he has good farm animals, and this satisfaction is no small asset in successful agriculture.

Pure breds versus scrubs. All these values of live stock on the farm are truer if we have pure-bred stock instead of scrubs. With the same amount of feed the pure-bred or well-bred animal converts it into the produce desired more efficiently. The good cow turns the food given her into larger and better quantities of milk; the good beef animal converts the food into large quantities of high-grade meat; the good hen utilizes her food in the production of the maximum amount of eggs in the fall and winter season; the good horse converts his food into energy and endurance at the minimum cost; and so on through the whole live-stock list. The pure-bred animals have been bred up so that the desirable characteristics are fixed and hereditary, and these characteristics are maintained by economical feeding and care. All this implies that well-bred animals bring more money on the market, and this fact alone would justify their production. The point made in the last paragraph that farm animals contribute to the pride of the farmers in his vocation is especially true of animals of the pure-bred type. The production of well-bred animals leads the farmer to improve his place, probably name his farm, advertise his goods, and bring to his home and family all the best things which an interest in good farm animals will bring.

CHAPTER X

THE HORSE

Horses and automobiles. Though the automobile and gas engine may seem to be displacing the horse in some instances, the high prices and great demand for good horses lead us to believe that mechanical power is not a successful substitute for the horse in all its work, nor that it is ever likely to be. We can not imagine a farm without horses. Probably most of our present enjoyment of comforts and conveniences is traceable to our friend and servant, the horse.

There are about one-fourth as many horses in our country as there are people, and about three-fourths of these horses are on the farm. We are indebted to the horses that do the work on the farms for the production of most of our food. Horses are increasing in esteem and numbers, and more attention is being paid to their health and comfort. The great question on the farm today is how to plan the farming operations so that the horse labor will be used more effectively, thus reducing the number of horses and getting more efficient use of those that remain.

The work of horses. Different kinds of horses are adapted to different kinds of work. One horse may draw a buggy along the road at the rate of ten miles an hour, and thus be

valuable as a roadster. Another may draw his share of a load of one ton or more and be of service as a draft horse. One may be just as useful to the owner as the other, each performing the work to which he is best adapted.

With horses as with men, work is the result of the action of the muscles. About 40 per cent of the weight of the horse is muscle. Muscles of locomotion are attached to tendons and bones, and by contracting and expanding cause the bones to move. The lower part of the horse's leg is nearly all bone, but the muscles which move it are in the upper part of the leg and in the body. The common idea about the muscles of horses is often expressed, "Long muscles for speed; short muscles for power." In buying horses to draw heavy loads, we look for large and heavy muscles, while in driving horses we attach greater importance to length of muscles. Most of the horse's propelling muscles are in the hind quarters, and if you watch a horse pulling a heavy load you may be surprised to see that most of the work is being done with the hind legs. It is very important that there be large, strong hocks; the croup should be wide and straight; quarters and thighs, deep and heavily muscled; the legs straight and placed squarely under the body.

It is very desirable, also, that a horse should have a rather short back; that is, short from the hips to the withers. We are to learn that the hind parts really push the rest of the body along; therefore a long back would hinder easy and rapid motion. Of course the front parts of the horse are very important; for no matter how strong the hind quarters are, if there is anything seriously wrong with the forelegs, he

can not travel well. The front knees of the horse should be large, straight, and angular, and, when viewed from in front, the feet should be in line with the legs.

Appearance of horses. Everyone likes to see a beautiful horse, and even if a person has not studied horses he knows an attractive horse with good style and carriage when he sees

FIG 18. A GOOD FARM TEAM

it. No matter what kind of work horses are kept to do, it is desirable that they look well. Much of the appearance of horses depends upon their flesh and fettle and the grooming they have had, but more depends upon the breeding. We like to see a horse with proper length of neck forming a crest rising upwards from the body, with the head and nose

pointed a little forward, the ears erect and rather close together, the eyes large and bright, and the whole body neat, trim, and gracefully poised.

Breeds and Types of Horses

Some horse history. The horse was probably the next animal after the dog to be domesticated. Its immediate ancestry is almost a matter of conjecture, since there have been no really wild horses within historic times. Down deep in the rocks, geologists have found remains of an animal that apparently was a relative of the horse. This ancient horse was smaller than ours, and, in place of one toe and hoof on each foot, he had three toes. Other remains were found of horses with five toes. The splint bones, the slender bones on either side of the long bone just below the knee, are all that is left of the two outside toes of the three-toed horse. The wild ass of Abyssinia, the zebra, and quagga of South America, are the modern relatives of our horses.

The early use of the horse was to carry man on his back in hunting the fleeter game, and in waging war. The horse has never been used for food except in France, though recently such use has been recognized in New York and in other sections as an emergency food. As man became more civilized, he found new uses for the horse, until now, in the twentieth century, even the gas engine can not detract from the great number of services which this beast performs. The various uses to which man has put the horse has caused the different types and breeds to develop. Draft horses are heavy and

strong and move best at a walk. They have been developed for power. Driving horses are built for speed and style, are quicker, and are characterized by long, even strides in the run and by great powers of endurance.

Thoroughbreds. Students of history will recall the great Crusades in the twelfth and thirteenth centuries, when England, France, and Germany sent warriors to rescue the Holy Land from the Saracens. They were strong men mounted on large horses of great endurance, but the warriors were surprised to find the Saracens mounted on splendid horses more beautiful than any they had ever seen, the agile Arabian horse, bred for a thousand years for speed and endurance. The Englishmen took some of these beautiful Arabian horses back home with them, and, by breeding them with the best of the old English horses, developed the Thoroughbreds. Darley Arabia, Gadolphus Arabian, and Byrley Turk are three Archian stallions that figure in the development of the Thoroughbred. They were used in tournaments or mock battles, in fox hunting, and also in horse racing. Only the pedigreed horses could enter the races, and hence they became known as Thoroughbreds. Thoroughbred is the proper name for the English running horse, the oldest established breed in the world, and this horse became the foundation for all American trotters and saddle horses.

Draft horses. The Arabian horses which the Frenchmen took back from the Crusades were bred with the common farm horses of France, and the modern Percheron is the result. Though as heavy as any other draft horse, he has good action inherited from the early Arabian stock. The

Belgian was developed from the old heavy horses of Flanders. The Shire and Clydesdale were developed from the old stock of heavy horses of the British Isles and the horses of Flanders. England early developed the coach horse, lighter than the draft horse but heavier than the Thoroughbred. The modern Cleveland bay is the descendant of this coach horse.

The farm horse. Of all the types of horses, the draft horse of from 1600 to 2200 pounds is the one the farmer

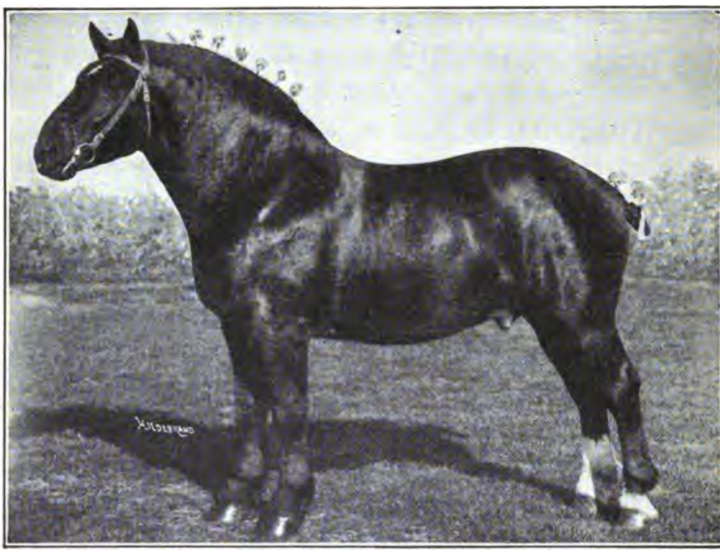

FIG. 19. A PERCHERON STALLION

maintains most successfully. This is because the weight and strength of the draft horses enable them to do the general work of the farm, and because they may be put on the market with less training than other classes of horses require.

FIG. 20. A SHIRE STALLION

The well-to-do farmer often keeps carriage or road horses. These are a kind of coach horse fifteen or sixteen hands high, of beautiful form, and even temperament.

The Percheron. The Percheron draft horse is a native of La Percha, France. It is noted for its massive size, good quality, endurance, and action. Stallions usually weigh from 1700 to 2000 pounds. They range from fifteen and one-half to seventeen hands high. The color is variable, though black and dapple gray predominate. This is the most common breed of heavy draft horse in the United States.

The Shire. The Shire draft horse was developed in England about 150 years ago. It is commonly known as the oldest breed of "cart horse" (this term is also applied to Bel-

gians), and for heavy draft it is unexcelled. Shires often make the heaviest of all draft horses, sometimes weighing 2300 pounds. Bay or brown is the preferred color, with white on the forehead and on the legs below the knees and hocks. Grays and blacks are common. Long hair on the back of the cannons is a breed characteristic.

FIG. 21. A CLYDESDALE MARE

The Clydesdale. The Clydesdale draft horse originated in Scotland. It is an active breed, not so massive as the Percheron nor so heavy as the Shire. The weight varies from 1600 to 2000 pounds. Bay or brown with white on the forehead and on the legs below the knees and hocks is the most

common marking, though there are many blacks and grays. Like the Shire, the long hair on the back of the cannons is a breed characteristic.

The Belgian. The Belgian breed has been developed to a high standard through the great interest shown in horse breeding by the people of Belgium and the assistance given by their government. Unfortunately, in pushing through Belgium in the present war, the Germans have almost totally destroyed the horse breeding establishments of these brave and courageous people. Before the war, however, many of these horses were brought to the United States each year and thus the breed will be saved. The Belgian horses are the blockiest of all draft breeds. They are not as large as the Shire, but being so thick fleshed are equally as heavy.

Grading up of horses. The term "grading up" applies to the practice of mating common bred mares to pure-bred stallions, or the reverse, thus producing half-breeds. Half-breeds mated back to pure breeds of the same breed will increase the pure blood percentage in the offspring from one-half to three-fourths, and the next such cross to seven-eighths, and so on for each successive generation. A constructive grading-up process for the average farm community would be by the male line of pure-bred ancestors.

If there are no enterprising, progressive men in the locality who are standing pure-bred, registered draft stallions, the first step would be to organize a community association to secure co-operatively the desired sires, and to promote the horse breeding industry. After a careful study of the mar-

ket, a class should be decided upon that is having a brisk demand in the sale ring, and a brood mare should be selected of that type and conformation. This will gradually eliminate for breeding purposes all those specimens described by the horseman as unsound, "stork" legged, "wasp" waisted, "washy" coupled, and of faulty action. Those chosen should not only be sound and of the desired conformation, according to breed and type, but should show their sex characteristics in head and neck, having expression mild, forequarters fine but well formed, chest deep, barrel roomy, and hips wide apart, indicating ability to exercise the maternal functions.

By mating these "hand-picked," sound, suitable grade mares with sound, muscular, pure-bred, registered stallions, the result cannot help but be promising. Continue to use the best obtainable pure-bred stallions of the same breed on the mares, and thus profit by the accumulation of the blood of the desired breed in the grading-up process. To mate a draft mare of the farm chunk type to a high-strung, standard-bred, 2:10 trotter with plenty of stamina or "class" may result in a fairly good foal from the cross, but one which does not fall under any of the established market classes and which would have to sell at a sacrifice. Not only will that particular cross be unprofitable, but further progress in grading-up will be stopped because the preponderance of blood of the recognized breed has been lost. If, on the other hand, a grade mare is bred to a stallion of the same breed used in her grading-up, her filly foal will be one step nearer pure blood than her dam, and, if the process is continued, further progress in establishing purity of blood and the other

desired characteristics which are associated with it will result.

The mating of mares to pure-bred draft stallions is not all there is in securing uniformity of type and conformation in the offspring; the feed, shelter, care, and handling are important items in producing good specimens of any class of live stock.

Judging the Horse

Points in judging the horse. The heavy draft horse is one of the most profitable classes of horses the farmer can raise. In judging the draft horse, as in judging all farm animals, these points are first noted: size, soundness, conformation, quality, action, and condition. In noting conformation, five main points must be observed closely: general appearance or form, head and neck, fore quarters, hind quarters, and body. These heads are subdivided into several minor points noted in the score-card, and one must study them carefully in order to be able to judge horses.

General appearance. To judge the general appearance of a horse, view him from both sides and ends at a distance of about 20 feet. Ascertain in your mind the height and weight, and observe closely the general form and conformation. The draft horse should be broad, smooth, and massive, with all bony projections well covered with flesh. The skin must be soft, the hair smooth and fine. Carefully observe the action of the horse. The stride should be straight, regular, long, elastic, and fast. The trot should be straight, springy, and free. While watching all the above qualities, the temper should be observed; the expression of

the eye and the carriage of the ears very often indicate the disposition of the animal.

Head and neck. The head must be clean cut, well carried; the profile straight and in good proportion to the size of the body. The eyes and ears should be examined with great care. Back the horse into a dark shed with the head to the light and place the hand over the eyes for about thirty seconds. Then remove the hand and watch the expansion and contraction of the pupils. The pupils should be of the same color, elliptical in shape, and should respond readily to the light by expanding and contracting. Examine the top of the head for any enlargement such as Poll evil. The ears should be medium in size, carried well forward, and alert. The jaws should be clean, uniform, and straight.

Fore quarters. The shoulders are especially important in a good draft horse. They should be smoothly muscled, moderately sloping, and extending well into the back. The arms should be short and heavily muscled, while the forearm should be longer and, from a side view, wide and well muscled. The knee seen from the front should be wide and straight. The cannons should be straight and short, and the tendons back of them strong and well set back from the bone. The pasterns should be moderately sloping, showing great strength. The feet should be equal in size and the horn thick and dense and not inclined to be brittle. The toe should be straight, not turned in or out, the soles convex, the bars strong, the frog long and elastic, and the heels wide and well sprung.

The body. The body includes the withers, chest, ribs, back, and loins. The withers must be broad and muscled to

the top, the chest deep and round. The breast should be wide and carried low, giving a large girth; the ribs long and well sprung. The back should be short, broad, and well muscled. The loins should be short, wide, and flat, and the underline should be long and moderately curved. The flanks full and even, denoting a good feeder.

Hind quarters. The hind quarters include more points to be noted than any other part of the animal. The thighs should be broad, smooth, and level; the croup moderately drooping, long, and heavily muscled; the tail attached high and well carried; the thigh deep, short, and heavily muscled; the quarter (between the thighs) plump and full; the stifle clean, round, and well fleshed; the gaskins long, wide, and smooth; the hocks, viewed from in front, broad, clean, and flat, and strongly supported below. The cannons are a little wider and longer than those in front; the pasterns and toes a little less sloping and shorter than those in the front legs. The feet are less rounding, but otherwise they should correspond exactly with those in the front.

The Feeding and Care of Horses

Feeding the horse. Considerable attention should be given to the feeding and care of the horse for the sake of his health and comfort. The horse has a small stomach and, therefore, should not be fed a large amount of food at one time; but that which is given must be nutritious. Nearly all diseases of the digestive organs are the result of improper feeding. Mouldy or musty foods should never be fed. A

number of serious digestive disorders among horses often result from feeding corn in mouldy condition. A rather recent trouble among horses is forage poisoning, originating from mouldy or other fungous growths eaten by the horse.

Rations for horses. Corn and timothy hay alone are not good feeding rations for working horses. In this feed there is not enough protein food to keep the horse in the best condition. Oats and corn, with mixed clover and timothy hay for roughage, make a fairly good ration for the horse. Alfalfa hay, if well cured, is good and a great favorite with horses; with corn and oats it makes a good ration for the working horse. Corn may be fed in the ear, shelled, cracked, or chopped. The chopped corn is too fine, however, to be well digested. Ear corn and oats, half and half, make a good food commonly used on the farm. Patent stock foods are not to be used under any circumstances. Horses should be fed three times a day, as follows: The grain ration divided into three equal parts and fed morning, noon, and night. One-half the hay should be fed at night and one-fourth at morning and at noon. In general about one pound of concentrate (grain) and one pound of roughage (hay) should be fed per one hundred pounds live weight of animal. A horse doing heavy work should receive from one and one-fourth to one and one-half pounds of concentrate and one pound of roughage per one hundred pounds live weight.

A fifteen-hundred-pound horse at heavy work should receive, if fed corn, oats in ratio of two to one, and alfalfa hay—fourteen pounds of corn (twenty ears) and six pounds of

oats (one and one-fourth gallons) and fifteen pounds of alfalfa hay per day.

Salt should be given to the work horses once or twice a week.

Watering the horse. The water horses drink does not lodge in the stomach but passes on to the large colon of the intestine, except when the stomach is full. When horses are very thirsty they immerse their whole nose in the water to prevent drawing in the air. Horses, like all farm animals, prefer and ought to have pure water. A good practice is to water immediately before and after each feeding, and, if the animals are to be left in the stall over night, to water again after their hay has been cleaned up.

Stables for horses. Stables should be wide and large enough to hold at least two cubic feet of air space for every pound of the horse's weight. The stables should be well lighted; the horse's head should not face the light. Air should not come in as draughts, but the stable should be well ventilated. The floor of the stalls should be higher in front than behind to allow good drainage.

Points in Good Horsemanship

Training colts. To be able to break and train a colt is an accomplishment which every farm boy should desire to acquire. Handling and caring for animals has a good influence upon the education and character of boys and girls. "The end to be accomplished in training a colt," says Dean Davenport in his 'Animal Studies,' "is to teach courage, obedience,

and good workmanship to this wild colt that was never off the farm, never saw the cars perhaps, and that never knew the feeling of halter or harness or experienced reprimand or control of any kind."

One can do little toward educating a colt until it can be haltered and taught to lead well. The halter should be strong and plenty of time should be given to teach the colt its first lesson in restraint. Teach it to lead gradually by requiring it to follow you for food. After a colt has been taught to lead, gradually accustom it to things that might frighten horses, as umbrellas, automobiles, blankets, paper, noises, etc. Be kind and speak in a reassuring voice during these trials of the young horse. The hardest lesson of all is to get the young horse to drive in harness. Do not hitch him at first, but teach him to back or turn to the right or left, etc., as you hold the lines. Give the colt the word that goes with every action he makes. Do not extend the lessons in breaking over one hour at a time. After the colt has submitted to be driven, hitch him to a cart. A draft colt can best be "broken" by hitching him with a quiet, gentle mare.

Then a new line of good horsemanship is needed, a few points of which we can merely mention here. Hold a tight rein and keep cool. Let the colt understand that "whoa" means to stop; "back" means to back; "steady" means to go slowly; and "get up" means to go on. Do not use unnecessary and contradictory words such as "whoa back" and "whoa haw," and never use profanity. Do not overwork or overdrive the horse. He is flesh and blood and not a machine.

It is best not to use the high over-check rein. The over-draw check is used for single harness, and the side-check or bearing rein for double harness work horses.

Keeping the horse comfortable. One point in good horsemanship is to see that the horse is properly shod. Every owner should understand how a horse should be shod, so that he can insist on the blacksmith shoeing him properly. Harness should be well fitted to the size of the horse. If the collar is too large or too small, sore necks will result, as well as other troubles. The harness should be kept well cleaned and oiled, not only to prevent rapid wearing out, but to give greater comfort to the horse. Never put a frosty bit into the horse's mouth. Warm it by breathing on it or holding it in the hand. The horse should never be left facing the cold wind, and should always be blanketed when left to stand in the cold. Examine the horse's teeth frequently. A horse can not eat properly when his teeth are poor. Use a curry comb and brush freely upon the horse, especially the brush.

Laws of the road. A good driver observes and knows all the courtesies of the road. He turns to the right and gives half of the road to those he meets, and all the road, if possible, to a loaded wagon. He permits anyone to pass who wishes to drive faster than he, and, if he passes another, he drives far enough ahead to avoid annoying him by the dust. Recent laws have been made in different states regarding the automobile and its rules in regard to horse traffic along the road, but a gentleman chauffeur and a good horseman need have no trouble about the laws of the road.

THE HORSE'S PLEA

Please give us water often.

Please give us a moment's rest on the way up the hill.

Please do not overload us and make us pull too long in deep mud; we are doing our best.

Please do not use the whip; it is seldom necessary.

Please remember we will respond to a word as well as to a blow.

Please look out for our health and do not work us when we are sick.

Please see that we are properly shod.

Please be sure that we have enough to eat and that we are fed regularly.

Please see that the harness fits and does not chafe sore or tender spots.

COMMON DISEASES OF THE HORSE AND WHAT TO DO FOR THEM

Symptoms of illness. There are many symptoms by which a farmer may detect when there is something wrong with his horses. The temperature, the pulse rate, and the rate of breathing may be of assistance to the farmer in examining the horse to determine whether anything is wrong with his health. Most farmers after a little experience can tell whether or not fever is present by placing the hand behind the foreleg, between the hind legs, or in the horse's mouth.

In particular cases of sickness considerable importance is attached to the attitude and action of the horse. In most

cases it is advisable to call in a veterinarian when the horse is ill, but the farmer should know the symptoms of some of the common diseases and should know what to do until the doctor comes.

Colic. The horse is subject to various forms of colic, some of which are quite dangerous and require immediate treatment. Wind colic and cramp colic are most common. In wind colic the horse appears dull, falls to the ground, and breathes hard. Pain is continuous. Charcoal given to the horse often relieves pain. In cramp colic pain begins suddenly and is often severe. It may be the result of indigestion. The horse looks back at his side, paws the ground, lies down, rolls, and gets up frequently. Whiskey and Jamaica ginger or camphor may give relief. In all cases of colic the first thing to do is to give the horse a good physic. One or two quarts of raw linseed oil with one or two ounces of turpentine is practical and best for this purpose. All farmers should have on hand about two or three ounces of fluid extract of wild yam, sometimes called colic root. Give the horse one teaspoonful every half hour until relieved.

Founder. This disease is known to veterinarians as laminitis. It is an inflammation of the horn secreting structure, usually showing digestive disorder or overwork. The disease is painful. The front feet are the most common seat of the disease, although any one or all of them may be affected. In case the front feet are affected, they are placed in advance of the body and the hind feet thrust away under it, appearing as if the whole body were sore, though only the feet are affected. When all four feet are inflamed, the horse can

hardly walk. Varying with the degree of the disease, the connection between the secretive and horny portion of the toe is more or less obliterated. The form of the hoof changes and the heel appears higher and more contracted. Rings form on the walls of the hoof, coming close together at the toe; the hoof is hot and feverish. The sensitive part of the toe, being exposed by the degeneration of the horny structure, is likely to develop horn tumors which are very painful and may result in chronic disorder. Early treatment by a veterinary surgeon may cut short the attack and prevent changes in the form and condition of the hoof. A physic of Epsom salts, one or two pounds, should be given. The horse should be led to a stream of running water and left to stand in it at least two hours; and then one hour out. Alternate this process several times for a whole day. If this can not be done, use sawed-off barrels or tubs and stand the horse in cold water as described above.

Lameness. On account of the unusual exposure to strains, the horse is subject to more forms of lameness than any of our domestic animals. Lameness may be due to strains of the muscles, ligaments, or the joint capsules in any part of the leg, shoulders, or pelvic girdles. Usually it is a very difficult matter to indicate the exact cause of lameness in a horse, and we can not describe the veterinarian's system of ascertaining this. Some of the forms of lameness may be mentioned very briefly:

a. **Splints** are the bony enlargements which lie between the knees and fetlock joints on the inside of the legs. These may become a cause of lameness.

b. **Ringbone** is a term applied to a bony growth around the bone just above the coronet of the hoof. This trouble is more serious than splints, but it is possible both to prevent and to cure it by methods which can not be discussed here.

c. **Bone spavin** is a bony outgrowth of the hock joint. It interferes in a serious measure with the usefulness of the horse. After spavin has become established there is not much hope of cure. A month or two of rest in the pasture is the best medicine for a spavined horse.

d. In addition to these bone diseases, lameness may be caused by various troubles about the joints, such as blood spavin, straining of the joints, or by various foot troubles.

Wounds. Too little attention is given to the treatment of wounds in farm animals. Lockjaw and blood-poison are likely to result from the neglect of wounds. Shallow wounds may become exceedingly sore and cause much discomfort to the animals. When cut surfaces are kept perfectly clean, the wound heals much more rapidly, but this is not always possible with farm animals. Never sew stitches in the horse's flesh. The wound should always be treated and bandaged if possible. Applying a solution of carbolic acid and covering the surface with iodoform, if the wound can not be bandaged, is a treatment which will prevent the entrance of germs and flies. The application of camphor to wounds also prevents the entrance of flies. It should be said in this connection that if farmers were more careful about the use of barbed-wire fences about horse pastures there would be less trouble from wounds among farm horses.

Moon blindness. This is the name often given to an inflammation of the interior of the eye. The trouble first appears as a flow of tears with inflammation. This occurs with the regularity of lunar phases; hence the term moon blindness, though the moon has nothing to do with it. From five to seven attacks usually result in the lens of the eye becoming opaque and the curtain of the iris growing fast to the lens, causing blindness. When the symptoms first appear, a small blister should be made an inch or two under the eye, and the eyes washed in cold water or a solution of boric acid, one teaspoonful in one pound of water. The disease is caused by damp, cold stables, wet, undrained soils, rank, damp fodder, lack of sunshine, indigestible food, and from hereditary tendencies; not from "wolf teeth," as some people believe. Of course, the removal of these causes is the first step in controlling this disease.

THE AGE OF THE HORSE IN VERSE

"Two middle nippers you behold
Before the colt is two weeks old;
Before eight weeks two more will come;
Eight months, the "corners" cut the gum.

At two, the middle nippers drop;
At three, the second pair can't stop;
When four years old the third pair goes;
At five, a full new set he shows.

The deep black spots will pass from view,
At six years, from the middle two;
The second pair at seven years;
At eight, the spots each "corner" clears.

From middle nippers, upper jaw,
At nine the black spots will withdraw;
The second pair at ten are white;
Eleven finds the "corners" light.

As time goes on the horsemen know
The oval teeth three-sided grow;
They longer get, project before,
Till twenty, when we know no more."

Notebook Questions

1. Have you read the story of "Black Beauty"?
2. Who said, "My kingdom for a horse"?
3. Have you read Longfellow's poem called the "Belle of Atri"?
4. List some of the uses of horse to man.
5. Name the different types and breeds of horses.
6. How does a horse move its head when biting off grass? Does a cow do the same?
7. Can you tell the age of a horse by his teeth? How?
8. How does a horse lie down? Get up? How does this differ from the cow?
9. What blemishes on a horse would spoil its sale if you were the proposed buyer?
10. How many men would equal the power of one horse?
11. Describe the action of a horse's legs in trotting, pacing, and galloping.
12. Bring some interesting article about horses and read it before the class. Briefly review this article in your notebook.
13. Sketch the diagram of the horse's body and write in the names of the parts as numbered on the diagram.
14. What humane work among horses do you think is most needed in your community?

15. What improvement in horses is most needed in your community?

Practical Exercises and Home Projects

1. **Report of home types and breeds of horses.** Fill out the following table as a report of the horses owned on the home farm:

Type, Breed and Color	Weight	Age	No. of Horses	General Condition

2. **Study of external parts of the horse.** Before a chart of a horse, or, better still, before a live horse, drill the members of the class in locating and naming all the most important external parts used in judging the horse according to the score-card. Every student should be familiar with the names and locations of the parts, and with the common blemishes found on the horse's body.

3. **Comparative judging.** Drill the students in placing a ring of horses, ranking them first, second, third, etc., according to conformation, quality, and condition. Let each student be able to give the reason for his ranking of the horses in the judging ring.

4. **The use of the score-card.** Let each student use the

score-card designated by the State Experiment Station and mark the points of the horse according to his best judgment.

5. **Harnessing a horse.** Have a horse and buggy brought to the schoolyard and let every two members of the class, working together, harness and unharness the horse and hitch it again into the shafts ready for driving. This may be made more interesting by assuming the nature of a contest, if desired. Practice in harnessing and hitching a team to a wagon is a good exercise. (A home project in cleaning and oiling a set of harness is advised.)

6. **Reports from experiences.** Let each pupil choose one of the following topics and report some of his own observations or experiences for a written or an oral recitation:

(a) Breaking a Colt.
(b) Choosing a Horse.
(c) The Horse Barn at Home.
(d) Some Laws of the Road.
(e) How We Care for Our Horses.
(f) A History and Record of Some Noted Horse.
(g) An Observation or Experience in Connection with a Severe Case of Sickness in Horses the Student Has Had.

7. **Determination of feed rations.**

A. A table of foods (amounts in 100 pounds).

Foods	Dry matter lbs.	Protein lbs.	Carbohydrates and fats lbs.
Clover	85.	6.6	39.1
Wheat bran..............	89.	12.	45.9
Corn	89.	8.	74.5
Timothy hay.............	86.8	2.8	46.5

B. Problem. What is the nutritive ratio of the following ration: 15 pounds clover hay, 6 pounds wheat bran, 4 pounds corn? Is this a good ration for a working horse?

Note: A nutritive ratio is the proportion of protein to carbohydrate and fat, and should be about 1:6 for a working horse.

C. Feeding standards for horses, per day, per 1,000 pounds live weight.

	Dry matter lbs.	Protein lbs.	Carbohydrate and fat lbs.
Horse at light work......	20	1.5	10.5
Horse at medium work...	24	2.0	12.4
Horse at heavy work.....	26	2.5	15.2

D. Determine the nutritive ratio and value as compared with the ration given in the paragraph above on feeding.

8. **Plan of a barn.** Draw a floor plan for a horse barn on a farm, providing places for harness, grain, box stalls, and vehicles.

9. **Some live-stock statistics.** Consult the last Yearbook of the Department of Agriculture, and list the number and value of horses in the United States.

10. **Some feeding determinations.** Determine the weight of one quart of corn, oats, and bran. Determine the size of a forkful of hay that will average five pounds.

CHAPTER XI

DAIRY CATTLE AND THEIR PRODUCTS

> "The summer days grew cool and late;
> He went for the cows when the work was done,
> But down the lane as he opened the gate
> He saw them coming, one by one."

The most important things to learn in connection with the farm dairy cattle are how to increase the production of milk, both in quantity and quality; how to fix these desirable characteristics in the cows, and how to feed such rations as will give the cow the best advantage of her breeding.

Home of dairy breeds. In the English Channel just off the coast of France are four little islands that belong to England. They are Jersey, Guernsey, Alderney, and Stark, in order of size. Jersey is just twenty miles across, and Stark is practically uninhabited. The isles of Jersey and Guernsey have each given us a breed of dairy cattle named after their native island and bred pure for many generations. It has long been against the law of the islands to land any live animals there except for immediate slaughter. From Scotland came the Ayrshire breed. In the eastern part of our country the Ayrshires have long been known and admired. From Holland came the Holstein-Friesian, the breed noted for the quantity or large flow of milk. In size they are the largest dairy breed. In America this breed is very popular for milk production to supply cities.

FIG. 22. A HOLSTEIN DAIRY HERD

DAIRY BREEDS

Name	Origin	Color	Approximate weight	Milk, quantity and quality	Distinguishing characteristics
Jersey	Jersey Isle	Fawn, shading to dark.	750 to 900 lbs.	Low average yield, high in butter fat.	High percentage butter fat. Yellow product, persistent milker.
Guernsey	Guernsey Isle	Reddish yellow with white markings.	1000 lbs.	Average yield not high. Rich in butter fat.	Production of highly colored cream and butter.
Holstein-Friesian	Holland	Black and white, not blended.	1200 lbs.	Abundant. Lowest in butter fat average.	High milk yield. Vigorous constitution. Good breeding quality. Quiet disposition.
Ayrshire	Scotland	Spotted red and white, not blended.	900 to 1100 lbs.	Large average yield, medium butter fat.	Less angular dairy-type. Horns turn upward, udder development excellent.
Brown Swiss	Switzerland	Brown in varying shades.	1200 lbs.	Large average yield, good butter fat average.	Vitality and good breeding. Quiet and gentle. Large calves.
Shorthorn (Dual-purpose breed)	England	Red, white, red and white or roan.	1400 to 1600 lbs.	Good average milk yield and butter fat content.	Larger than any dairy breed. More numerous and widely distributed. Good breed calves.

General characteristics of dairy cattle. The form or shape of farm animals shows their special adaptation for the use to which they are put. Good specimens of animals that are what we call well-bred always belong to a distinct type. Among farm cattle we distinguish three types: the beef-type, the dual-purpose-type, and the dairy-type.

FIG. 23. TILLY ALCARTRA

Our first impression upon comparing the dairy-type with the others is that the dairy cow shows her ribs and muscles plainly. Her body is deep and angular. Seen from in front, she seems narrow; her breast is thin and her neck long and slender. Seen from behind, she is wide and has a large udder between thin, muscular legs. Looking down over her back, you will notice that she is broad in the middle and narrow

in front. Such a wedge form is characteristic of the dairy-type.

The udder. The milk gland or udder is the most important part of the dairy cow. When it is of good shape it extends well forward and behind, with four teats uniformly placed, wide apart, and large enough for convenience in milking. On the under side of the body in front of the udder are large milk veins, one on each side, twisting along and finally disappearing in holes called the milk wells. These veins carry large quantities of blood from the udder. The cow's udder is a wonderful mechanism, and is of great capacity. Good cows give from six to ten times their weight in milk in a year. A world's record cow, Tilly Alcartra, a Holstein, gave 30,452.6 pounds of milk in a year.

Points in judging quality. Stockmen often speak of high-class animals as having good quality. This is shown in a fine silky coat of hair, in a soft, elastic skin, in fine bones, and in neat joints. When an animal has quality you can easily take the skin in the hand between the thumb and fingers and pull it out from the side of the body. It is pliable and will roll up in the hand easily. If the cow lacks quality or is not in good condition, her skin will be thick and tight and is not easily taken in the hand. The dairy cow of quality is likely to be a better producer of milk than one in which quality is lacking.

In all judging work in public-school agriculture the points to note and emphasize are the form, quality, and condition of the animal. When a farmer wants to buy a dairy cow, the question naturally confronts him, "How

shall I be able to judge a good dairy cow?" In doing this he must know the proper form of the head, neck, fore quarters, body, and hind quarters of the dairy-type. He must know what good quality consists in, and be able to know at sight whether the animal is in good condition or is capable of being put into good condition, depending upon health and breeding. All points in judging may be considered under the following heads: constitution, temperament, capacity, milking organs, and mammary development.

Hind quarters. In judging the form of a dairy cow, the hind quarters are most important. The hips should be far apart and level. The rump should be long and wide, with plenty of hip room. The pin bones should be prominent and wide apart. The tail should be long and slim, with hair in the switch fine. The udder should be high and full behind, long, and extending full and far in front. The teats should be large and evenly placed. The milk veins should be large, long, and very crooked. When large they indicate much blood coming from the udder, showing large secretion capacity.

The body. The chest should be deep and low, and the barrel large, showing digestive capacity, with ribs well sprung and wide apart. The back should be lean, straight, open-jointed, and flexible.

Fore quarters. The fore quarters are not so important. The whithers should be lean and thin, the shoulders light and very oblique, and the legs straight, short, and fine.

Head and neck. The muzzle should be clean cut; the mouth, the nostrils, and the eyes should be large. The eyes

should have a mild expression. The face should be clean, long, dished, and expressive of maternal qualities and good disposition. The forehead should be broad. Horns should be even in length and of fine texture. The neck should be thin, of medium length; the throat clean; the dulap thin and of very fine texture. A cow with a thick, coarse head and neck does not designate good dairy quality.

The first practice in judging dairy cows should be comparative judging, ranking the cattle in the ring in the order of their standing based upon the points mentioned above. All points in judging should be related to improved production and breeding.

Products of the dairy. Milk, butter, and cheese are the products of the dairy. Every day we use some form of these products in our homes. The Yearbook of 1910 of the U. S. Department of Agriculture gives the following statistics on dairy products:

	Pounds
International trade in butter exports	640,000,000
International trade in cheese exports	509,000,000
United States export in butter	3,000,000
United States export in cheese	3,000,000
United States export in milk	13,000,000

By comparing the value of the dairy products of the country with those of other agricultural lines, we note that the dairy product ranks fourth, with corn, live stock, and hay ranking in order as named.

Milk. Milk is composed of six constituents which are of prime importance. The following table gives the constituents of the milk with the percentage of each:

	Per cent
Water	87.
Fat	4.
Casein	2.6
Albumin	.7
Sugar	5.
Ash	.7

More important for our lesson than the composition is the question of the care and handling of milk. The most important item in the handling of milk is cleanliness. Probably no other kind of food is more difficult to keep clean than milk. Thousands of bacteria from the air get into the milk, some of which cause the milk to sour, while others may be the germs of consumption, typhoid fever, and other dangerous human diseases. The following precautions in the care of milk should be taken by all who furnish us with this valuable food:

First, the milker should have clean clothes and clean hands, and should never wet his hands with the milk. Second, the cow should be clean, the udder and teats should be wiped with a moist cloth, and the stables well lighted, aired, and cleaned. Third, every vessel used in the handling of the milk should be scalded and scrupulously cleaned. Fourth, the cows should not be milked where the air is full of dust of any kind. Fifth, the surface of the milk should not be left exposed to the air of the cellar, kitchen, or any place where dust or bacteria may fall into it. Sixth, the milk should be cooled quickly and kept cold.

Butter. Butter is composed largely of fat, so we speak of the fat of milk as butter fat. Fat, although most valuable

on the market, is not the most important food constituent of milk. Butter fat is composed mainly of nine different fats. On account of the importance of the fat, it is often made the basis of payment for milk. By means of the Babcock tester the amount of butter fat in milk can be accurately determined. This amount ranges from 2 per cent to 6 per cent. Cream contains most of the butter fat in milk, and it thus becomes an important item to separate the cream from the milk in order to get the greatest amount of butter fat. Experiments have shown that from the three methods of cream separation the following results were obtained:

Butter Lost in Skim-Milk from 1 Cow in 1 Year

Hand separator	Loss of butter	2.6 lbs.
Shallow pan	Loss of butter	60. lbs.
Water dilution	Loss of butter	70. lbs.

It is easily seen that a good hand cream separator is a profitable piece of apparatus to have on the farm keeping three or more cows.

Cheese. We learned that casein is one of the constituents of milk. It contains protein, one of the most important food elements of milk. This casein is separated as curd by the souring of milk, but the separation may also be made by adding cheese-making rennet. The curd formed by the rennet is then heated, the whey drained off, and later run through a mill and cut into small pieces, salted, pressed to form, and finally cured in a cool room before it is ready for the market.

Cheese is one of the most nutritious of foods and should be more largely used in our diet.

Problems Showing Comparative Value of Cows

1. A farmer owns six cows, Bess, Spot, Brindle, Boss, Kate, and Red.

Bess	gives 22 lbs.	milk daily,	testing 3.8	per cent butter fat
Spot	gives 15 lbs.	milk daily,	testing 4.2	per cent butter fat
Brindle	gives 30 lbs.	milk daily,	testing 3.5	per cent butter fat
Boss	gives 30 lbs.	milk daily,	testing 3.0	per cent butter fat
Kate	gives 14 lbs.	milk daily,	testing 3.2	per cent butter fat
Red	gives 24 lbs.	milk daily,	testing 5.2	per cent butter fat

Figure out the yield of each cow, and classify the cows in order of production.

2. Three herds of ten cows each were compared. The Holstein-Friesians averaged 30 pounds of milk each daily; the Jerseys averaged 25 pounds each daily; the scrub herd, 10 pounds each daily. The Holsteins' milk tests 3.4 per cent butter fat, the Jerseys' 5.1 per cent, and the scrubs' 3.5 per cent. Which is the most profitable herd? With butter fat at 30 cents per pound, what is the average monthly receipt per cow of each herd?

Remarkable difference in dairy cows. *Rose was an Illinois Experiment Station cow with a record that made her famous. Her total production for twelve years was 87,102.3 pounds of milk—43½ tons; 10,248 gallons; 1,281 cans of eight gallons each; 106 wagonloads of twelve cans each. Allowing three rods for a team, this would make a procession one mile long, six carloads, making a good milk train.

Butter for twelve years, 4,318.36 pounds, worth at present prices 25 cents per pound, $1,079.59.

*From Circular No. 106, Illinois Experiment Station.

Skim-milk for twelve years, 72,585 pounds, worth 15 cents per 100 pounds, $108.88.

Total receipts for twelve years (not reckoning calves or manure), $1,188.47, or $99.04 per year.

Just think what the receipts of a dairyman would be whose herd consisted of twenty-five cows of this kind—$2,500 per year, not counting calves and manure.

Rose was bought for $50 when 4 years of age. She had only ordinary treatment, no better than she would have received on a good dairy farm. She had not been pampered or fed to produce the utmost amount of milk.

Remarkable as was the performance of this grade cow, she was heralded not as standing apart in unapproachable splendor, but as a great leader of the thousands of money-making cows in Illinois.

In the same herd Queen became conspicuous for a very different reason. She had six years' record of 152 pounds butter fat per year, and, in exact comparison for one year, Rose made more than three times as much butter fat as Queen from exactly the same feed both in kinds and amount, and with the same care.

Quite unsuspected these Queens have everywhere honeycombed dairy profits. All of them are "star boarders." The more of them a dairyman keeps, the poorer he is. The way to find out—the only sure way—is to weigh and test the milk of each cow.

The world's record milk production for one year is held by the following individuals of their respective breeds:

Ayrshire	Garclaugh's May Mischief	25329	lbs. of milk.
Jersey	Passport	19695	lbs. of milk.
Guernsey	Murnie Cowan	24008	lbs. of milk.
Holstein	Lutoke Vale Corcopia	31334.2	lbs. of milk.

The world's record fat production for one year is held by the following individuals of their respective breeds:

Ayrshire	Lillie of Willomoore	965.6	lbs. of fat.
Jersey	Sophia the 19th of Hood Farm	999.2	lbs. of fat.
Guernsey	Murnie Cowan	1098	lbs. of fat.
Holstein	Duchess Skylark Ornsby	1205.09	lbs. of fat.

FIG. 24. A FINE TYPE OF GUERNSEY

Farmer boys and calves. A boy on the farm has not had his full experience if he has not owned and cared for a calf. Many a farmer boy has had his interest in agriculture aroused

and made permanent by a share in the live stock of the farm, and this share may begin with the ownership of a calf.

Calves of dairy cows. In order to have the best milkers among dairy cows, it is best to take the calves from them when they have nursed once after birth. These calves should then be fed the mother's milk by hand. Feed the calf about two quarts of its mother's milk three times a day for two weeks, then feed three quarts twice a day. Another way to estimate the amount is to feed about one pound of milk to ten pounds of live weight at first, increasing to three pounds of milk to ten pounds of live weight. After about a month keep whole oats in a box before the calf all the time. In addition to the milk, feed shelled corn with clover hay; this will make a good ration and cause the calf to grow.

Calves of the beef-type should be allowed to run with the mother, for such cows are not kept for their milk and the calves will do better on natural feeding.

Sheltering and caring for calves. The most important item in caring for young calves is the feeding and sheltering. Calves are fed either to bring to maturity as milk cows, to fatten for veal, or to push for the market as fat steers. To make finished beeves for the market by August, calves weighing from 400 to 500 pounds, they must be pushed along rapidly. The following ration has been successful: Nine to 12 pounds corn, 3-6 pounds good clover or alfalfa hay, 8-10 pounds silage, daily. If one or two pounds of cottonseed meal are added to this ration, the calves may be brought to 900 pounds or more in eight or nine months. The main thing in feeding, however, is to be governed largely by the

appetite of the calves and by common sense. Calves that are to be fattened for veal should in most cases be fed on new milk. Sweet skimmed milk furnishes a good basis for calf feeding. To this may be added a porridge of corn-meal or flaxseed meal with some fine wheat hay or grass. Kentucky blue-grass is a splendid balanced ration for growing calves.

Feeding and Caring for Cattle

Feeding compounds. The animal body contains widely different tissues: bones, flesh, brains, hair, etc., and the body tissues and the animal products contain many complex compounds. The food that the animal gets must contain all the elements that make up the animal body and its products. For the purpose of study, these foods may be included under the following heads: water, ash or mineral matter, protein, carbohydrates, and fats.

Purpose of feeding. We feed cattle to repair the broken-down tissues in their bodies, to make them grow, to keep their bodies warm, to produce energy for work, and to make special products such as meat and milk. The young growing animals require sufficient food to keep their bodies in repair, to keep them warm, and to make them grow steadily.

Foods and their special uses. It need merely be mentioned that water is indispensable to animal life, and that cattle should be given free access to an abundance of water. Ash or mineral matter is essential to the health of cattle. The most abundant mineral food is phosphate of lime. Min-

eral foods are found in water, in soil, and in the ordinary rations fed to live stock. Protein is the flesh-forming food. It is used for the production of flesh, tendons, and blood, and forms the casein and albumin of milk. Protein is obtained largely in such feeds as clover hay, alfalfa, oats, wheat, bran, and middlings, cottonseed and oil meal. Carbohydrates and fats furnish material for the production of body heat, muscular energy, body fat, and milk fat. Corn and timothy hay are rich in carbohydrates and fat. In addition to these foods, cattle need a certain amount of crude fiber. This includes such bulky foods as straw, fodder, and hay, which contain a large amount of indigestible material. This crude fiber acts as a stimulant to the digestive organs, giving them work to do in disposing of it.

Balanced rations and nutritive ratio. A balanced ration is one that has the proper amounts of protein, carbohydrate, and fat to secure the animal product desired, and to keep the animal in a healthful condition. The nutritive ratio is the proportion of protein to carbohydrates and fat. To find the nutritive ratio of any ration, divide the total amount of carbohydrates and fat in the ration by the total amount of protein, thus, $\frac{c + 2\frac{1}{4} f}{p}$. The balanced ration usually given for a dairy cow is one in which there is about six times as much carbohydrates and fat as protein. The nutritive ratio in this case would be 1:6. To feed cattle wisely, one should know the total amount of food needed daily, the composition of the food, and the nutritive ratio required for the special purpose for which the feeding is done.

Cattle feeds. The number of materials available for cat-

tle feeding has increased in marked degree during the past few years. The foodstuffs of vegetable origin may be included under four classes: forage crops, roots and tubers, seeds and grains, and by-products of various kinds. Silage is a comparatively recent food in this country. It is the name given to a green fodder preserved in the silo.*

Indian corn is cut at about the time when three-fourths of the kernels are dented, then ground—stalk, leaf, ear, and all—and stowed away in the silo. This makes a most valuable and economical food for dairy cattle, especially if fed with alfalfa.

A good balanced ration for a milch cow is 8 pounds of hay, 30 pounds of silage, and 8 pounds of grain, daily. If the silage is not obtainable, then the following is a good substitute: 20 pounds of hay, 6 pounds of grain, 3 pounds of dried beets. Another ration might be 3 pounds corn-meal, 2.5 pounds bran, 1 pound cottonseed meal, 15 pounds clover hay, 7.5 pounds corn stover. This ration contains 22.8 pounds dry matter, 2.08 pounds protein, and 12.5 pounds carbohydrate and fat, and has a nutritive ratio of 1:6.

Good rations for meat production in cattle are as follows: 8 pounds alfalfa hay, 12 pounds corn-meal, 5 pounds ground oats; or, 6 pounds clover hay, 12 pounds corn, 10 pounds silage, 2 pounds cottonseed meal. The amounts given above are figured for 1,000 pounds live weight. Of course, it is not to be inferred from all this detail of figures that the farmer is to weigh out every day the rations for each

*Silos are tall, round structures used for preserving green fodder for winter use.

animal. After these rations are weighed out a few times, giving half in the morning and half in the evening, the feeder will soon learn to estimate the amounts necessary to make up the ration.

Notebook Questions

1. What are the most needed improvements in the dairy cattle on the average home farm?
2. Where are the original homes of the dairy breeds?
3. Name the typical dairy breeds.
4. Explain the wedge form of the dairy cow.
5. What adaptations in the structure of the dairy cow contribute to milk production?
6. What is meant by quality in cattle?
7. What is meant by condition?
8. Describe the appearance and record of the three record dairy cows.
9. What is the most important food constituent of milk?
10. What is a good ration for baby beeves?

Practical Exercises and Home Projects

1. **Report of home dairy cattle.** Let the pupils make a report upon the dairy cattle at their home, as follows:

Breeds of cows	No. of cows	Selling value	Average daily milk production

Compare the reports of each pupil. Account for differences in selling value and milk yield.

2. **Table of stock foods with percentage of digestible nutrients.**

Food	Dry matter per 100 lbs.	Protein	Carbohydrates and fat
Silage	20.9	.9	12.87
Corn	89.1	7.9	77.
Clover hay...........	84.7	7.6	16.37
Cottonseed meal......	91.5	38.1	43.

By using the above table, figure out the nutritive ratio for the rations given for dairy and beef cattle in the above paragraphs.

Note—By referring to tables for all stock foods the nutritive ratio for other feeding rations is determined.

3. **Reports on home feeding.** Let the pupils report upon the kinds of stock feeds used at home. Give the amounts of grain and roughage fed each cow, and determine whether it is a balanced ration.

4. **Observational study of external parts of the dairy cow.** With a cow or a large chart before the class, drill in the naming of the external parts of the cow until they are familiar to every member of the class.

5. **Use of the score-card for dairy cattle.** Bring from one to three dairy cows to the schoolyard or let the class go to a dairy herd. Use the score-card recommended by the State Experiment Station in judging each cow, after several lessons in placing the animals in order of their rank

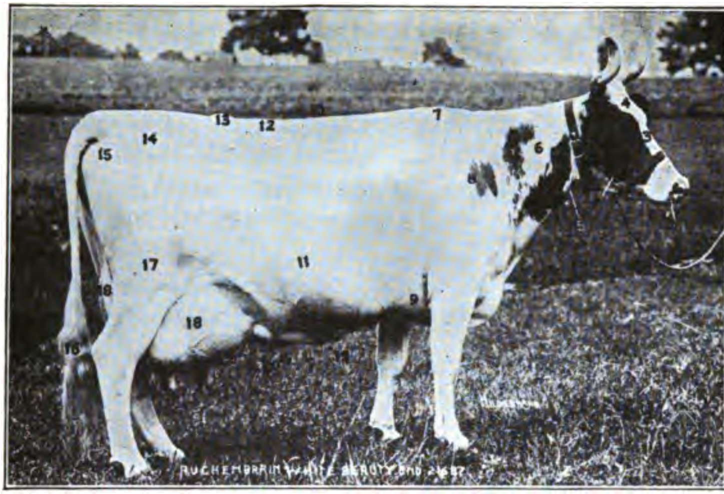

FIG. 25. DIAGRAM SHOWING EXTERNAL PARTS OF A COW

1. Muzzle. 2. Jaw. 3. Face. 4. Fore-head. 5. Throat. 6. Neck. 7. Withers. 8. Shoulder. 9. Chest. 10. Back. 11. Ribs. 12. Loin. 13. Rump. 14. Rump. 15. Hips. 16. Tail. 17. Thigh. 18. Udder. 19. Belly. 20. Milk Veins.

according to form, condition, and quality, as mentioned in a previous paragraph. Have each pupil make a copy of the score-card in his notebook, and when the cow is before the class let each pupil mark the points as he thinks proper.

6. **Daily milk records.** Pupils should make out a daily milk record sheet as follows, and keep a record of the cows at their homes for at least seven days.

Name of cow	Morning pounds	Evening pounds	Total pounds

Pupils should bring these records to school and compare reports.

7. **The Babcock test.** If possible, the school should procure a Babcock milk tester and test the milk of cows at the homes of the pupils. It is not necessary to give details for the use of the tester here, for directions accompany every machine. A good four-bottle Babcock tester may be obtained for ten or twelve dollars.

8. **Report on the calves owned by pupils.** Let the pupils each write a paper about the calves at the home farm, using the following outline:

(a) Number and breed of calves.
(b) Size and age.
(c) Ownership.
(d) Method of feeding.
(e) Shelter provided.
(f) Successes and failures in raising.
(g) Purpose for which kept.

CHAPTER XII

SWINE

SWINE ON THE FARM

Importance of hog raising. Since swine multiply rapidly and breed at an earlier age than other farm animals, they are considered one of the most profitable kinds of live stock which the farmer can produce. The prices of hogs vary so often and so much upon the great markets that the supply throughout the country is constantly shifting. The man who makes money out of hogs is the man who produces hogs each year and makes them a part of his permanent farm business. A few hogs might be kept profitably on many farms where they do not find a place today. The hog utilizes much of the by-products of the farm which might otherwise be wasted. In cattle feed lots, in dairy districts, in general farming operations, and, in fact, wherever man produces agricultural products, the hog may be used to convert the waste products into an economical meat supply. Experience should enable a farmer to determine just how many hogs he can raise on his farm to advantage.

Some pig history. The peccary of Central America is the American relative of the pig; at least it resembles the pig in habit and appearance. The wart-hog of Africa, the rhinoceros, the hippopotamus, and the wild boar of Europe are

some wild relatives of the domestic hog. It seems that the hog and his relatives came originally from southeastern Asia, and that we are indebted to the Chinese for our swine. The

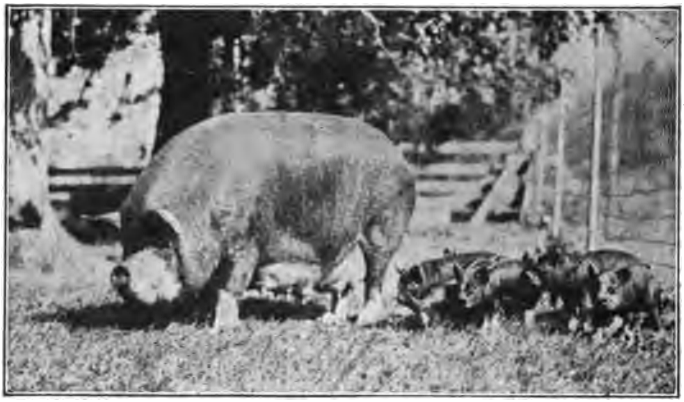

FIG 26. A WELL BRED FAMILY

European breeders improved their early Chinese hogs by crossing them with the large wild boars of western Europe. In this way the English Berkshire breed was formed. The English took the lead in developing the domestic hog as they did in improving cattle. The Indians had no hogs, but when the European settlers found that Indian corn made excellent feed for hogs, they had them sent over from England. Thus the hog and corn developed rapidly together in America, and the fat type of swine was produced. Among the first to breed and develop swine in America were the Dutch farmers of Chester County, Pennsylvania; they developed the Chester Whites, the first breed of American hog. As the country became settled westward, the counties in southern

Ohio around Cincinnati became the great swine region of the United States. Here the Poland China hogs were developed. Other domestic breeds of hogs were developed in Canada and throughout England.

TYPES AND BREEDS OF SWINE

Two types. There are two well-defined types of hogs, the fat or lard-type and the bacon-type. The lard-type is a product of the corn belt. In the great corn producing states we find the lard-type in its highest degree of perfection. Bacon hogs have not been produced to any great extent under

FIG. 27. LARD-TYPE OF HOG

systems of corn feeding, hence we find the bacon hog in greater numbers in countries where the food for the hog is more varied. Canada, Denmark, and Ireland are able to compete in their export trade with the bacon-types, because the "Wiltshire Side" (the side, ham, and shoulder in one piece) commands a higher price than the meat of the lard hog in export trade.

The lard-type of hog. The lard-type of hog has a com-

pact, thick, deep, smooth body. The ham, back, loin, and shoulders are the most valuable parts and are developed to a high degree. The production of lard and fat is the principal aim of this type. Quality is denoted by fine hair, smooth, clean, unwrinkled skin, rather fine bone, and an even distribution of flesh. The jowls should be broad, plump,

FIG. 28. BACON-TYPE OF HOG

and full, and the body not flabby in appearance. The hog should have short, upright pasterns. The snout should be fine, the face wide between the eyes, and the space between the ears wide and full. Width between the eyes and fullness and width between the ears indicate a good feeder. The neck should be short and deep and should blend smoothly into the shoulder. The shoulder should be well developed, blending well into the body and covered evenly with flesh

over all parts. The back should be broad, slightly arched, of medium length, and thickly fleshed. The ribs should be well sprung, the sides deep and even between the shoulder and ham. The ham should be broad, deep, plump, and heavily fleshed well down toward the hocks. The rump should be as wide as the back. The legs should be short, straight, set well apart and squarely under the body. The above brief description is general for all breeds of the lard hog. The Poland China, Chester White, Berkshire, and Duroc-Jersey are the popular breeds of this type of hog.

The bacon-type. The weight of this type of hog for market demands varies from 160 to 200 pounds. The product sought in this type is the "Wiltshire Side," the upper half of a side from shoulder to ham. The form of the bacon-type is quite different from the form of the lard-type. The hog has longer legs, the body is not so thick or deep, the shoulders, neck, and jowls are lighter. The hog should be long from shoulder to ham, with sufficient depth and thickness to denote good constitution. Quality, as in the lard-type, is indicated by a smooth coat of hair and an unwrinkled skin. The finished bacon hog handles firmer to the touch than a finished lard hog. The bones of this type are larger, but they should present a clean-cut appearance. The loin is the most valuable cut in this hog, and should be as wide as the rest of the back, full, strong, and well packed with flesh. The ribs should spring out boldly from the backbone and turn sharply downward, giving a straight, flat side. The leading breeds of the bacon-type of swine are the Tamworth and the Large Yorkshire. Sometimes the Hampshire is so classed.

Selecting the stock. The farmer who wishes to raise hogs should make the start with a few first-class animals. It is better to purchase one first-class brood sow than several mediocre ones for the same money. The same is true of the boar. He should be a pure-bred animal of the type selected. The following are some characteristics of a good breeding sow: the forehead should be broad and the eyes wide apart; the neck rather thin; the shoulders smooth and deep; the back wide and straight; the chest deep and broad; the ribs well sprung; and a long body showing capacity from end to end. She should stand on straight legs and well up on the toes. She should be selected from a prolific strain and be a creditable representative of the breed. A good boar should have a masculine head and well-crested neck, and the same indications of a good pork-producing body as described for a good sow.

Breeds of Swine

Various tests in feeding swine have demonstrated that no one breed is superior to all others in ability to make cheap gains. A healthy, thrifty hog will make economical gains no matter what breed it represents. The various breeds have their peculiar excellencies, and it becomes a matter of personal choice in determining what breed to raise. It is advisable for best commercial interests, however, for a community to confine its swine production to the same one or two breeds.

The Berkshire. The Berkshire is an attractive animal, rather above medium size and belongs to the lard-type. The

face is dished, the snout short, the jowl full and heavy, the neck short, and the ears erect. The body of the Berkshire is long and smooth, with a thickly meated, neat, trim ham. In this breed the bone is strong and clean, but the animal does not always stand well on its feet. The standard color is black with white markings on the face, on each foot, and on the tip of the tail. It attains good weight at an early age, fattens readily and is known for its excellent quality of meat. The breed came originally from Berkshire in England.

The Poland China. The present day Poland China is a large hog, some of the boars weighing over one thousand pounds. The face is slightly dished, the jowls are full and heavy, and the ears are fine and droop at about one-third of their length. The shoulders and hind quarters are heavy and the sides are straight and deep. As a rule the legs are short and the bone fine. The color is black, with white on face, feet, and tip of tail—"black, with six white points." The Poland China is especially a lard-type of hog. It is a fine yielder from the packer's standpoint. No breed excels the Poland China in ability to produce a finished fat carcass for the butcher at an early age. It has developed on corn feeding and is a great favorite in the corn belt. The breed originated in the Miami Valley of Ohio.

The Duroc-Jersey. The Duroc-Jersey is a large hog of the lard-type. The snout is medium length, the face usually straight. Durocs have a characteristic arched back. Cherry red is the common color, but chestnut and yellowish red are

often seen. The Duroc is a good grazer as well as a good corn feeder. This breed is very prolific and crosses well with several other breeds. The red pigs get their name "Jersey Reds" from New Jersey, where they gained considerable prominence, and "Duroc," a breed, strange to say, named after a stallion, from Duroc, in Saratoga County, New York. The breeders of Jersey Reds and Durocs united under the name "Duroc-Jersey" and have developed this excellent breed in later years.

The Chester White. The Chester White is a large white hog of the lard-type. The face is straight, the snout medium, the ears are heavy and droop at the tip. The conformation of the Chester Whites is similar to that of the Poland China, but they have wider backs and lighter hams. The Ohio Improved Chester Whites (O. I. C.) is a strain resulting from an attempt to improve the Chester White through selection.

The breed matures early and is an economical feeder. It is a good grazer and fairly hardy. Admirers of the Chester Whites claim the breed ranks among the first in being prolific. The breed originated in Chester County, Pennsylvania.

The Hampshire. The Hampshire is a medium-sized hog coming between the lard-type and bacon-type of hog. The face is straight, the ears incline forward but do not droop like those of the Poland China. The shoulders, ham, and jowls are lighter than those of fat hogs. There is less width of back and more length of side. The most fashionable color "listed" consists of black extremities with a white belt from four to twelve inches wide encircling the body and including

the fore-legs. Although the Hampshire does not suit the demands of the "Wiltshire Sides" for British export trade, the breed as a bacon-type is well suited to American demands for bacon. The Hampshire is a breed growing in popularity and has a reputation for good, fine-grained flesh with a high per cent of lean, dressing out with excellent net weight for packing. It is an active, hardy breed and is giving good satisfaction both as a feeder and breeder. The breed originated in Hampshire, England.

The Large Yorkshire. The Large Yorkshire is one of the largest breeds of swine. It is a typical bacon hog. The face is dished, the snout practically straight, the ears are large and erect, the shoulders and back of only medium width, the sides are long, and the ham carries very little fat. The bones are heavy, and the legs longer than those of the lard-type of hog. The color is white, with pinkish skin. There is a tendency to wide variation in many points in this breed. The Large Yorkshire is highly valued for bacon production. For quality of bacon it is rivalled only by the Tamworth. The breed is of English origin.

The Tamworth. The Tamworth, like the Large Yorkshire, is a large-sized hog of the bacon-type. It has a long, straight snout, and the ears are large and fringed with fine hairs. In conformation the Tamworth is similar to the Large Yorkshire. The color is commonly a golden yellow, which grows darker with age. The bacon of the Tamworth is highly esteemed in export trade. This breed is of English origin and takes its name from Tamworth in Staffordshire.

Feed and Management of Swine

Pig diet. The pig can make more meat from the food he eats than any other animal, with the possible exception of the hen. Five and one-half pounds of corn should make a pound of pork. Although we usually think of the pig as a grain eating animal, he will eat a greater variety of food than any other domestic animal. By choice his diet would include grain, grass, nuts, roots, snakes, worms, etc. Hogs should have access to pasture, for grass is a healthful diet for them. Clover, alfalfa, peas, and rape are excellent summer foods for the development of hogs, while in winter roots or silage, together with the grain ration, should be regularly fed. Every pig should have free access to charcoal or coal screenings, ashes, slacked lime, and salt.

During hot weather the hog craves a pool of water to reduce his temperature, for he perspires but little. In winter warm shelter for hogs reduces the amount of feed necessary.

Supplementing corn in feeding hogs. Corn is essentially a fat forming feed, and is, therefore, not a good bone and muscle producer. Exclusive corn feeding works great harm in the case of young growing pigs, and numerous experiments have been conducted in combining other feeds with corn in order to overcome its objectionable features. When properly combined with a supplementary feed, relatively rich in protein and minerals, corn is the best hog feed obtainable. Pasture is an excellent supplement to corn, especially clover and alfalfa. Tankage and meat meals may be given in small

proportions when used in dry lot feeding or in full feeding on pasture. When hogs are on pasture, tankage supplements the corn most economically. Soy beans also afford a valuable supplement to corn.

General care and management. Many farmers seem to think that hogs require but little care and attention. The filthy pens where hogs are often compelled to wallow and feed, the damp, dark, ill-ventilated boxes in which they are often

FIG. 29. A GOOD HOG HOUSE

confined, and the dirty slop which constitutes such a large part of their diet, show the vile neglect and inhuman treatment often given to this valuable farm animal. Good, wholesome pork is not produced under such circumstances. It is better to fatten the hogs in a ten-acre field than in a ten-foot lot. The hog is a voracious feeder, but he responds readily to wholesome food by giving returns according to treatment and care.

Hog houses. Good hog houses will have reasonable warmth, sunlight, cleanliness, dryness, ventilation, and convenience. Hogs are sensitive to extremes of heat and cold

and should have houses for shelter and shade. The house should be located on a dry site where the drainage is good. The beginner should not put up expensive buildings. The above mentioned important qualities of the hog house may be secured in many ways to suit the convenience and financial condition of the grower. Much attention is being given to the construction of good hog houses, and details may be obtained from the state experiment stations, or from the U. S. Department of Agriculture, Washington, D. C.

Some points in the care of a brood sow. It is not advisable to breed the sows before they are eight or ten months old, and in most cases it is best to wait three or four days after the pigs are weaned before breeding her again. The period of gestation in sows is 112-116 days. Most farmers will find that it is safer to have their sows farrow in March and September, producing two litters each year. A good pasture affords ideal conditions for the brood sow. During the period of gestation the sow should be kept in good condition but not over-fat. An exclusive corn diet can not give best results, because it does not furnish enough bone and muscle forming constituents for unborn pigs. Equal parts of ground corn, ground oats, and wheat middlings is the ration recommended for the brood sow. There should be an abundant supply of fresh water at all times. The farrowing pen should be dry, well ventilated, and free from draughts. Equal parts of ground oats and wheat middlings, allowed to soak between feedings, is an excellent ration for nursing sows. If sweet skim-milk can be added, the ration

is almost ideal. A limited amount of bulky, succulent feed helps to keep the sow healthy.

Care of little pigs. Little pigs should be allowed to get on the ground and in the sunshine as soon as the weather is moderate. After three weeks they should have other food in addition to the sow's milk. Skim-milk or oatmeal gruel is an excellent diet for little pigs. Some succulent feed, such as green clover and roots, will soon be relished by the growing pigs and should always be included in the diet. A small amount of soaked whole corn scattered over the floor of the pen is good food for the pigs and will cause them to exercise while hunting for it. Skim-milk and middlings make about the best feed for young pigs after weaning. At no time should the growing pig be given an exclusive diet of corn. The most profitable time to feed pigs is during the first ten months of their life. After ten months of proper feeding, pigs should weigh from 250 to 300 pounds. Pigs fattened for the market should never see their first birthday anniversary.

Hog cholera. This dreaded disease among hogs is due to a filterable virus and causes a loss of many millions of dollars annually. Hogs show symptoms of the disease in going off to lie in cool places. Their hind parts seem stiff and they stagger as they walk; there is a watery secretion from the eyelids; alternate diarrhoea and constipation are common. Little can be done by way of treatment for this disease. Preventive measures are the only effective means of combatting hog cholera. Quarantine, isolation, and disinfection are im-

portant measures in fighting the disease. Three methods of vaccination are used in preventing the cholera:

(1) The injection of an anti-cholera serum, which makes the hogs immune only a few months or weeks.

(2) Simultaneously with the serum is injected the defibrinated blood or virus of a diseased hog, rendering the hog immune for life.

(3) In the combination method, very seldom used, the hog is vaccinated with the serum alone and ten days later the simultaneous method is used. These plans of combatting the hog cholera must be carried out under the direction of a skilled veterinarian, and the state should supply the serum to the farmer at cost.

Markets. The successful stock man is the one who is familiar with market requirements and tries to meet them. Every pig club member should know something of the market classes and grades of hogs. These differ somewhat according to local conditions, but in a general way the classification given below may be taken as a standard.

Heavy hogs are no longer at a premium except when the price of lard is high. They contain a large amount of fat.

Butcher hogs are commonly used for fresh meat trade. They are principally barrows.

The term *packing* refers to animals which are inferior as butcher hogs and are cut up, cured, and packed in boxes and barrels. Mixed packing hogs are those marketed without grading.

The meat of young pigs is unsuitable for curing and supplies part of the demand for cheap, fresh meat.

The bacon hogs quoted on the Chicago market are lard hogs that are not highly finished, have a high per cent of lean meat, and supply the demand for lean pork.

MARKET CLASSES AND GRADES

Class	Weight	Sub-Class		Grade
Prime heavy..	350-500	....		Prime
Butcher.......	180-350	Heavy	280-350	Prime, Good
		Medium	220-280	Prime, Good, Common
		Light	180-220	Prime, Good, Common
Packing.......	200-500	Heavy	300-500	Good, Common, Inferior
		Medium	250-300	Good, Common, Inferior
		Mixed	200-280	Good, Common, Inferior
Light.........	125-220	Bacon: English	160-220	Choice, Light, Fat
		Bacon: U. S.	155-195	Choice, Good, Common
		Light light	125-150	Good, Common, Inferior
		Light mixed	150-220	Good, Common, Inferior
Pigs..........	60-125	....		Choice, Good, Common
Roughs.......				
Stags.........				
Boars.........				
Misc..........	....	Roasting pigs, Feeders, Governments, Pen holders, Dead hogs		

Stags are males castrated too late in life to grade as barrows. Boars are used for sausage and supply cheap, fresh meat.

The present demand is for hogs weighing from 200 to 250 pounds, and the hog raiser should aim to finish and market his hogs at about these weights.

Notebook Questions

1. Why is hog raising such a popular form of live-stock production on the farm?
2. What were some of the most needed improvements brought about in swine over their wild relatives?
3. What are the chief differences between the bacon- and lard-types of hogs?
4. What are the characteristics of a good brood sow? Of a good boar?
5. Name the standard breeds of swine in this country.
6. What is your favorite breed, and why?
7. What are some of the feeds supplementary to corn in productive swine feeding?
8. Give some reasons why swine should be sheltered. What are the essentials of a good piggery?
9. Name five points you consider essential in the care of the brood sow.
10. List some interesting hog habits.

Practical Exercises and Home Projects

1. **Reports upon the wild relatives of the swine.** Pupils should prepare written reports upon the following wild relatives of the hog: peccary, wart hog, rhinoceros, hippopotamus, wild boar, etc., consulting geographies, natural histories, and encyclopedias for information on these animals.

2. **Report on swine at the home farm.** Let the pupil report on the swine on the home farm by filling out the following table:

Types and breeds	Number of each	Characteristics of each	Average weight	Estimated value

3. **Quotation of market prices.** Pupils should report the market prices of hogs and various pork products as quoted in the daily papers they receive at home or at school.

4. **Observation and study of breeds.** If at all practical, the class in Agriculture should take a trip to the various farms in the community and observe the different breeds of swine. The pupils should be able to tell the difference between the Berkshires, Poland China, Chester White, Duroc-Jersey, or any other breeds found in the community. The distinguishing characteristics of these breeds should be noted and thoroughly learned on a trip of this kind.

5. **Comparative judging.** Prepare a ring of swine, two, three, or four animals, and have the pupils place these according to rank, basing their judgment on form, condition, and quality of the swine in the ring. In doing this exercise it may be necessary for the instructor to go over the whole matter of conformation, condition, and quality, as they should be found in good swine.

6. **Exercises in judging.** After the students have become somewhat familiar with the points in judging swine, information may be given as to the judging of individuals by the score-cards. Under the direction of the instructor use the score-card of your State Experiment Station.

7. **Reports on home meat production.** Let each pupil report on the methods of feeding and managing swine at home, using the following outline:

(a) The house, pen, or range in which the pigs are fed for fattening.

(b) The feed used, amount, kind, etc.

(c) Criticism of the above methods, and suggestions for improvement.

8. **Houses.** Students should bring pictures of hog houses, clipped from farm papers or other publications in which they may be found, and in class make a critical study of the illustrations assembled. Ground floor plans should be drawn by each student for several types of house.

CHAPTER XIII

POULTRY

Arguments for poultry raising as a school study. There is no phase of agriculture that interests and directly concerns so large a proportion of people in any community as poultry. We find poultry on practically every farm in the country and, to a large extent, in the towns and cities.

Poultry raising requires very little capital, very little area, and one does not have to wait long for profits. A large num-

FIG. 30. A GOOD TYPE OF HEN

ber of chickens may be raised in the same period of time it takes to grow a crop of corn. The products, both meat and eggs, are always in demand and in season the year round.

The principles of feeding, breeding, and general care are the same for poultry as for other kinds of live stock, and may be studied with practical demonstrations in any school.

The hen as an efficient machine of production. Poultry raising is one of the most profitable branches of animal husbandry. All our domestic animals are kept on the farm for the purpose of converting the products of the soil into animal products, and tests that have been carefully made by different experiment stations show that there is no class of domestic animals that converts the grains, forages, and waste products of the farm and the insect pests of our crops so economically into animal foods as does the hen. Three and a half pounds of grain, fed from the time the chick is hatched up to the time it weighs from four to six pounds, is required for one pound of chicken. It takes five or six pounds of food to make a pound of pork, which is the next cheapest meat.

The standard farm breeds and their special points of excellence. Our economic fowls may be divided into three general classes:

(a) The type known as the egg class, or Mediterraneans, generally small, light birds, including Leghorns, Anconas, and Minorcas. These are of special interest to the poultry keeper because they produce a pure white egg. They have been developed for egg production. They are often spoken of as the egg fowls, but they are not really the greatest egg producers, as some fowls of other breeds produce just as many eggs. The point that makes them especially popular is that eastern markets, such as New York City, Philadelphia, and also the Pacific coast, will pay more for a pure white egg

than for a brown-shelled one. The only class of hens that will lay the pure white egg is the Mediterranean.

(b) The meat type, known as the Asiatics. There are three breeds of particular importance: Brahmas, Cochins, and Langshans. The first two are not noted as great layers, though the Brahmas are fair layers. The Langshans are among the

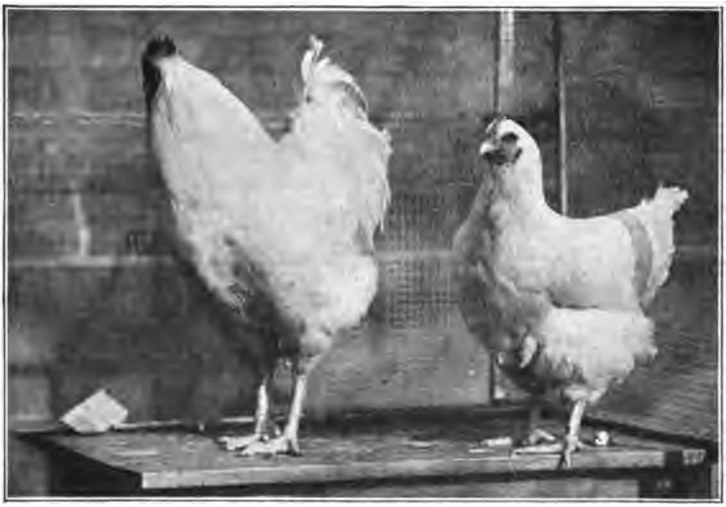

FIG. 31. THE DUAL-PURPOSE-TYPE

very best layers, competing quite favorably with others in the egg contests. This type is called the meat breed, because the fowls are heavy and make the big roasters. They are very valuable in the eastern states, especially in Boston. "Green roasters" or "soft roasters" are very much in demand, bringing as much as 35 cents per pound live weight, and weighing from 6 to 9 or 10 pounds when dressed.

(c) The general purpose or American class, the type popular among the people generally. This type combines two characteristics to a high degree—egg production and meat. The breeds especially notable are Plymouth Rocks, Wyandottes, Rhode Island Reds, and Orpingtons.

The Plymouth Rocks are fowls that weigh from 6 to 10 pounds. They are a very hardy breed and lay good-sized eggs.

The ability to produce a great many eggs is not a matter of breed, but of breeding or strain. The individual must be selected and bred with reference to its particular characteristic, whether it be appearance, plumage, meat weight, egg-laying power, or what not. This principle holds good with all classes of fowls, even with the meat class. The Langshans in Australia, for instance, often lead the list in the egg-laying contests there. The Mediterranean type is capable of being developed into great layers.

The Plymouth Rocks were the first American breed to be developed. They were given their name solely for patriotic reasons.

The Wyandottes. The second American breed to be developed was the Wyandotte, an Indian name. They are about one pound smaller than the Plymouths; that is, they weigh from 5½ to 8½ pounds and are very compact and round. The Wyandotte is called the bird of curves. For broilers of from ¾ to 2 pounds, they develop rapidly. The birds of the meat class are not best to eat, usually, until they weigh about 3 or 4 pounds.

The Wyandottes have a rose comb or double comb, which

is a low, fleshy tissue quite different from the single comb that stands up more prominently. This low comb is less exposed to the cold. Some people in the colder sections of the country think it is better to have a breed with the rose comb, but the preference is largely a matter of fancy.

Rhode Island Reds were the latest breed to be developed in this country. They are believed to be the hardiest and most vigorous of any of our American breeds. They are the same size as the Wyandottes, and a pound smaller than the Plymouth Rocks. Raised under similar conditions, when mature, a Plymouth Rock that is true to her breed and type should weigh a pound more than a Wyandotte or a Rhode Island Red. The Rhode Island Reds are naturally great layers. At several experiment stations it has been demonstrated that they are the great money makers, although some pens of Plymouth Rocks have contested them closely. The Rhode Island Reds lay a large and very perfectly shelled egg. Some say the Rhode Island Reds eggs can be picked out from a basket by touch, because of the marble smoothness of the shell.

The Orpingtons are an English breed. They are classed with the Plymouth Rocks, Wyandottes, and Reds because, for the general purposes, they are midway between the light and the heavy in size. They are about half a pound larger than the Plymouth Rock, and are like the other English breed birds in having a white instead of a yellow skin. There is a feeling among a great many people that a yellow skin indicates a richness and juiciness of flesh. There are no table birds superior to the Orpingtons. The skin is very tender,

and they fatten well for a table bird. They are also excellent layers.

There are three varieties of Orpingtons; white, buff, and black. They are beautiful to look upon, having fluffy feathers somewhat looser than the American breeds. They have a single comb, but it is not large and thus not exposed to the cold.

Improvements. Probably the most desirable improvement to be sought on the farm is strong, healthy birds with a maximum of egg production, especially during the winter months. There is no reason why as great an improvement in egg production should not and may not be secured by the poultry keeper as the dairy keeper has secured during the past few years in the production of milk. The dairyman found out that a large proportion of the herd did not pay for their feed. The same is true with poultry. Weak, unhealthy birds are always the centers of disease, because poultry is kept in larger numbers and the individuals are not so directly under the eye of the keeper. There is more danger of starting diseases in a flock than there is with other kinds of domestic animals. By weeding out the unhealthy birds one may be saved much loss and disappointment.

The relative value of feeding and breeding in egg production. If we regard fowls, as we do our other domestic animals, as machines whose business it is to convert as profitably as possible the produce of the soil (the feeds) into high-class, desirable, animal products, then, first, it is to the interest of the poultry keeper to make sure that his machine is

as perfect as he can get it; that is, that his poultry is well bred. So much for the machine.

Then everybody knows that if he has ever so valuable an engine or machine of any sort, to make it the source of the greatest possible profit he must have materials to work up into the product. The more one can make the fowls eat, if the food is not fed wastefully, the greater should be the profit. If one can breed fowls to develop the characteristic of early laying and early maturity, which would mean in the fall and winter, they would be of the greatest profit. Two hens may lay equal numbers of eggs, but one may bring in three or four times as much profit as the other, because she lays at the time when eggs sell at the highest price.

Some good feeding rations for laying hens. One of the best rations, and the simplest, is grain, wheat, and corn only, fed morning and night, spread in the litter, changing the proportion according to the season. In the fall and spring feed equal amounts of wheat and corn; in the summer, one part of corn to two parts of wheat; in the winter, two parts corn to one part wheat. Keep coarse ground oats in the feed hopper all the time. These are foods which are easily procured by the poultry keeper whether in town or on the farm.

Mixed with these ground oats in dry mash (formerly they used wheat bran, wheat middlings, and ground corn) is about 15 per cent of meat scrap. This is the by-product of the packing houses; it is cheap meat and some cartilage, etc., ground up, cooked, and dried, so that all the germs are

killed. It can be stored and kept just like wheat bran. Formerly it was called beef scrap.

One can not get profitable results from fowls without feeding some kind of animal food. The town poultry keeper has enough table scraps to answer the purpose, and in the summer the fowls can get insects easily, which accounts for the fact that summer laying is much more common than winter laying. If hens produce winter eggs, they must be fed meat scrap or some other animal food. If the farmer can profitably do so, he should use skim-milk or buttermilk. The fowls will drink this, and the meat scrap may be omitted. The meat scrap is the most expensive element of the ration, costing about 3½ cents per pound. Feeding buttermilk to hens is one of the most profitable uses that can be made of that by-product.

Poultry keepers should feed oyster shells. These help to form the eggshells. Analysis shows that the composition of the oyster shell and the eggshell is almost identical. The oyster shell dissolves rapidly enough to provide the calcium carbonate. Grit must also be fed, though many people think that either one is enough. Grit is a granite or any material hard enough to grind the food. Coarse sand or gravel is used by many poultry raisers, but the round particles in the sand or gravel are not sharp enough to grind; the prepared chicken grit or ground granite is much more satisfactory.

In addition, the chickens should have some kind of succulent feed. That may be apple parings, potato parings, cabbage, beets, etc. Sprouted oats are now be-

coming one of the most popular feeds, because they can be grown easily in the winter in any basement where they will not freeze. A very good substitute is finely cut alfalfa or clover hay on which warm water is poured and allowed to steep over night.

Much emphasis must be placed upon the water. We learn what should be fed fowls by the composition of the egg. The hen is not a wizard and can not make a product of materials which do not contain all the constituents of the product. Over 65 per cent of the egg is water. If she does not get her liquid either in water or milk (when we give buttermilk she gets both water and protein), the hen can not manufacture eggs. She must have a constant supply of liquid. Few people give the chickens enough to drink, particularly the laying hens. Hens will consume much more water when they are laying. This same indication may be seen in the oyster shells. They will not touch the shell until they are ready to begin laying. And since water or milk is one of the best carriers of disease germs, it is necessary to make sure that the drinking vessels are kept clean, and that the liquid put in them is clean and pure. In warm weather it should be kept in the shade.

Essentials of a good poultry house. The order in which the essentials are mentioned does not mean that one is more important than the other; they are all necessary.

1. Freedom from dampness.
2. Freedom from draughts (no cross draughts).
3. Excellent ventilation.

4. Cheerful surroundings; plenty of light.
5. Room and convenience.

Without all of these five conditions, one can not have a good poultry house.

FIG. 32. A GOOD POULTRY HOUSE

The necessity of housing chickens in cold weather. The best results in the production of winter eggs—which is really the profitable side of poultry keeping—are obtained by keeping the chickens housed from the time cold weather starts in the fall until spring comes. The fowls should not touch their feet on the ground out-of-doors during the winter months. For breeding flocks it is desirable to give a little more opportunity for exercise. If you are trying to breed, do not plan to get winter eggs at all. In this case egg production should not begin until you are ready to set the eggs. Most people, however, are interested in getting winter eggs.

School poultry. In the school work of hatching and rearing young chickens, either the incubator or the hen may

be used, preferably both, wherever a school equipment will permit it. One should not attempt to use an incubator in connection with any school unless there is a basement in which it may be kept safely and under fairly good conditions.

Descriptions and illustrations of ideal hen houses for keeping young chickens, the brood coops, etc., will be furnished by the state experiment stations. The children in the country school can easily make the coops and use them in egg-laying contests. In these contests each pupil sets a hen in one of these coops. A prize is given to the pupil who raises the largest number of chickens; another to the pupil who raises the greatest number of pounds of chicken; another to the owner of the chickens that score the highest, etc.

Some sanitary measures in the prevention of diseases among poultry. Common poultry ailments can be divided into three classes:

(a) Those that affect the respiratory organs.

(b) Those that affect the digestive organs.

(c) The parasites.

The kind of poultry house described on a preceding page is the best preventative for the first class of diseases. The most serious disease among poultry is roup, which is a catarrhal cold resulting from secretions of the head, from which the chicken can not free itself and which become putrid and poison the system. A simple remedy is: a little ointment made of camphor, eucalyptus oil, menthol, and oil of cloves, applied with a sewing machine oil can through the nostrils into the cleft roof of the mouth. It is an almost absolute cure.

A preventative of digestive troubles is granulated charcoal. It is not a food or a medicine, but a corrective.

The greatest protection against any ailment is to have only healthy, vigorous, breeding stock. Healthy stock and sanitary conditions will eliminate most poultry troubles. The best protection against the spread of diseases which are generally carried through drinking water is to use crystalline potassium permanganate in the water. This destroys organic matter. A few crystals in a quart of water will color it purple, and will be sufficient for the purpose. For protection against parasites, keep the houses clean and spray frequently with a mixture of coal oil and crude carbolic acid. The best protection against lice is an application of a mercurial ointment. A piece about as big as a pea rubbed in the fluff over an area of about one square inch will protect the chicken for a month.

The water-glass recipe for preservation of eggs. Use one part of liquid water-glass, which can be bought at about 75 cents per gallon, with nine parts of ordinary drinking water. It is best to boil this water first to expel the air. Mix thoroughly. Put the eggs into a two-quart fruit jar. This will hold about sixteen eggs and require about one quart of the solution. Screw the top on. The eggs will keep in large stone crocks without covers, but after the liquid is exposed to the air it begins to thicken in the bottom, and the eggs which have thin shells will be a little alkaline to taste after several months. If a fruit jar is used and the lid is screwed on tight, the liquid will remain as clear as water.

Poultry judging. If the community is interested in prac-

ticing poultry judging, gather in a number of birds and add to the interest of the work by scoring. Scoring is easily taught. Almost any good poultry text now gives the score-card and full descriptions which are easily understood.

The poultry business. The experiment stations advise farmers who are at all interested in poultry keeping to organize the poultry just as the dairyman does his cows into a unit large enough to keep one person busy all the time. A unit of not less than 500, and as many multiples of this as possible, is advisable. An elderly person or an invalid could take care of 500 chickens, except for occasional heavy work.

There is no line of agricultural work that promises so large a profit as poultry raising. All our large poultry industries are showing that it is a conservative estimate to expect a hen to lay twelve dozen eggs in a year; a few record hens have laid 300 eggs. It costs about a dollar to feed a hen a year. At twenty-five cents a dozen as the selling price, there would be three dollars return for the egg products, or two dollars profit above the cost of feed. When you have a unit of 500 chickens making a profit of two dollars or even one dollar each per year, you have a pretty good income from that branch of your farming. Then, too, poultry combines readily with many other forms of agriculture. Poultry with fruit, poultry with truck gardening, poultry with dairying,—all these are excellent combinations.

Notebook Questions

1. Give three good reasons why poultry should be raised on the farm.
2. Name ten standard breeds of farm poultry.
3. What is your favorite breed and why?
4. Give one good feeding ration for egg production.
5. Why must the chickens have oyster shells and grit?
6. Why are green foods, meat foods, and water so essential in the chicken's ration?
7. Name four essentials of a good poultry house.
8. What is the purpose of the trap nests?
9. What is meant by developing desirable strains in poultry?
10. List six or seven common poultry ailments.

Practical Exercises and Home Projects

1. **Reports on home poultry.**

Breeds	Number of Fowls	Characteristics	Profitableness

2. **Poultry records.** Each student during the period of poultry study should keep a feeding and egg record of the

flocks at home. The records should be kept for at least ten days, and a full report given by each student in the class at the end of the period.

3. **Trap nests.** In order to determine which hens in the home flock are laying, the trap nest may be used as part of the practical work of this study. Students should install trap nests at home. These nests may be purchased at the poultry supply house, or an ingenious boy may make them. The manual training department of the high school would find this piece of work practical. The hens caught in the trap nests are numbered by leg bands. In selecting eggs for breeding purposes, the eggs laid by these trapped hens are very desirable, especially if laid in the winter time.

FIG. 33. A TRAP NEST

4. **The egg.** (a) For this exercise pupils should bring to the class a few eggs for study and observation. As an interesting introduction to the study the instructor may tabulate on the board the following data for the collection brought in:

Pupil's Name	Breed of Chickens	Color of Egg	Weight	Size	Form

Pupils should copy this table in their notebooks and fill in the information gained.

(b) **Practice in examining eggs for freshness.** Provide a large shoe-box and a lamp or other light for this exercise. Place the light in the box and hold the egg between the light and a small hole made in the side of the box through which the observer may examine the egg. If no cloudiness is seen in the egg it is fresh. Examine a number of eggs by this method.

(c) Let each pupil break open an egg in a saucer and note the following points in its structure: The germinal disc, which appears as a light colored spot on the upper surface of the egg and contains the life principle of the yolk. It should be noted here that the egg with its white and yolk is a single cell; the egg of the ostrich being the largest single cell in animal or plant life. Note the whitish cords of denser albumin which serve to keep the yolk properly suspended in the white of the egg. Note the clear watery appearance of the white of the egg. This is albumin, the food in liquid form upon which the young chick lives while in the shell. The chemical composition of the egg is as follows: Shell, 10.7%; albumin, 11.9%; fats, 12.8%; salt, 7%; water, 63.9%.

(d) For this part of the study each pupil should have a hard boiled egg. Carefully remove the shell, piece by piece. Observe the air space and the two membranes beneath the shell. Cut the egg lengthwise through the middle. Make a drawing of the section, showing all the points mentioned under (c).

5. **Preservation of eggs.** Refer to the paragraph in the chapter describing the method of preserving eggs by means of water-glass. As a practical exercise in this study, the

class should preserve eggs in water-glass according to the directions given until the method is familiar to all.

6. **House plans.** Students should sketch in their note-books plans of the poultry house on the home farm, and other plans of modern poultry houses, showing the essential requirements for good poultry house construction.

7. **Judging poultry.** Bring as many samples of chickens to the laboratory as possible, and drill in naming the external parts of the chicken's body as a preparation to the more difficult work of using the score-card. Use the state score-card in practical scoring of poultry at hand.

8. **Writing an advertisement.** Each student should write a suitable advertisement for strictly fresh table eggs for sale to retail trade. Make it for a business card two by four inches. Neatness and facts are the two points to be given special care in writing such an advertisement.

PART III

FARM BUSINESS AND LIFE

CHAPTER XIV

THE BUSINESS OF FARMING

The farmer a business man. Farming must be considered not only as a productive industry, but as a business and a mode of life. In the early days of farm life the farmer raised about everything his family needed. The village store supplied his extra needs, and a few dollars a year sufficed to meet all expenses. With the improved methods of agriculture now coming thick and fast, the farmer needs more money. He must produce more, buy more, and sell more. All these changes demand that the successful farmer be a business man. He must organize the farm, as do business men of other large lines, into a successful business enterprise. The average land owner of the Middle West has as large an investment as the city business man. Successful business men are not easily made. There seems to be a certain native business sense born with some men,—yet a business training in the principles and methods of good business helps to make the farmer a better manager, as much so as such training contributes to success in other business careers. Common sense business ability combined

with experience, scientific knowledge of plant and animal production, manual and mechanical skill, and hard work are the requirements for a successful farmer.

The farmer's labor income. Labor incomes of farmers are not usually large, but they are measures of the farm's efficiency. Studies have been made of farm incomes over various parts of the country, and in the best regions the farmer's labor income rarely averages over $600. Besides this, the farmer makes interest on his capital, and has a house and farm products in addition.

Some thoughts for the farm boy. Of course not every farm boy should choose farming as a vocation, but every boy should think twice before deciding to leave the farm. The farm boy has a good training for agriculture, and many a city youth envies this opportunity to choose an agricultural career. High salaries paid in cities are misleading, and, when the cost of living is taken into account, the salaries often dwindle to low figures. Farming is not easy work, but it assures a competence, a freedom from economic disturbances, a healthful life, and an opportunity to enjoy all that is best in the world. If one is to be a farmer of the twentieth century, he should prepare for the business. An agricultural education given in a good four-year high-school course or in a good agricultural college is desirable in preparing a young man for the business of farming as it will be carried on in the next decade.

Some problems in farm management. It is not the purpose of this brief course to teach much about farm business. Merely to introduce the student to some of the problems

of farm management should give ideas of the importance and of the value of the business side of farming, and lead to a further study in more specialized courses.

(a) The first large problem is the type of agriculture to carry on, for this will determine the capital, labor, equipment, and land investment. Shall the type be general farming, live-stock farming, grain farming, fruit farming, truck farming, or the more specialized types such as hog raising, wheat farming, apple growing, poultry raising, etc.? Climate, soil, topography, transportation, markets, capital, labor supply, and the personal desires of the farmer will all be factors in making a choice.

(b) A second large problem is whether the farmer shall do intensive farming on fewer acres and permanently maintain his soil fertility, or whether he shall do extensive farming,—mining the soil's fertility to get the largest crop possible from as large an acreage as possible, with no consideration for the permanency of the soil's fertility. This often becomes a real problem to the man trying to pay off a mortgage on a large farm in a few years.

(c) The rotation of crops to utilize the maximum of land yielding profitable crops each year, and still to maintain the fertility of the soil, is a practical problem constantly before the farmer.

(d) The amount and kind of live stock to keep is a problem in most farm business. Whether to sell the grain and hay or to feed it to live stock, how much feed it will take, whether to buy feeders, or to raise one's own stock, are live questions in farm management.

(e) The balancing of rations, the maintenance of feeding standards, the keeping of records of animal achievement and production, the cost of feed stuffs, the housing and general care of animals, the improvement of breeds, are all problems of live-stock farming.

(f) The amount of capital to invest in farm buildings and machinery in order to have both convenience and comfort as well as profitable money returns is another question.

(g) The employment of sufficient reliable labor when needed is a difficult farm problem. Whether to plan for special or steady labor, how best to utilize the labor, what to pay, etc., are labor problems constantly recurring on the farm.

(h) The lay-out of the farm and the arrangement of lots, fields, and buildings is a problem of no small concern. Upon the proper lay-out depends much of the economy in labor, equipment, and time in operation, as well as the general beauty of the farm's appearance.

(i) The general question of keeping books connected with the buying and selling as well as with the records of crops and animals, is a problem too often neglected by the busy farmer, who should employ better business methods.

Marketing. The marketing of farm products is as much a part of the business of farming as the production of the crops. It is not altogether an individual problem to find a successful market, but often a community or public question. If products are stored or held for higher prices, allowance must be made for cost of handling, insurance, shrinkage, etc. In most cases, wherever it is feasible, it pays to

hold products for the month when the market prices of the products are the highest. The United States Department of Agriculture, Washington, D. C., sends free on request the *Crop Reporter*, and this publication is of great value in all marketing of farm products. The question of marketing is how to sell,—whether to sell direct to the consumer or to commission men and distributing agencies. Direct marketing of farm products is likely to develop only through coöperation and farm organization. When farmers and consumers are properly organized, direct buying and selling can be carried on and some of the unnecessary costs of handling eliminated. Express companies and the parcel-post system are doing effective leadership in some localities in bringing producers and consumers together in retail marketing. Grain elevator companies and large truck and fruit farmers have solved some of the problems of marketing by pooling their interests together and selling through their own paid agents. Products should never be sent to an unknown commission man. Whatever the system of marketing may be, certain principles should always be observed in making the selling of farm products a success. The goods should be honestly graded, measured, and labeled. The products to be sold in small quantities should be put up in clean, neat, and attractive packages, and a reputation should be established for the sale of first-class plant or animal products. When these principles are followed, the market seeks out the farmer, and his success is more certain.

Farm records and accounts. Every farmer keeps some simple account of his business, if it is nothing more than

keeping track of who owes him and whom he owes. It becomes a simple matter of arithmetic to keep books, recording debits and credits. Men in the more up-to-date business of farming are doing more than mere bookkeeping; they are keeping careful cost accounts and other records for the purpose of learning how to conduct the business more efficiently. Every farmer can make some estimate of costs and what things are paying him. There are many kinds of records that are desirable on farms, such as milk records of individual cows, feeding records, breeding records, crop yields. weather records, orchard records, drainage maps, performance records of animals, etc.

In all simple bookkeeping use the left hand page of the book for debits, and the right hand page for credits.

Enter on the left hand page cash paid by you to the account, goods sold by you, work done by you, or any item for which you are not paid.	Enter on the right hand page cash paid to you by the account, goods delivered to you, or any items for which you must pay.

The following are some examples of accounts and records advisable in farm business.

1. **A personal account with a hired man.**

Harry Farrington

Commenced work April 1, 1915—at $50 a month

April	11	Cash............	$10.00	May 1	One month's work, April	$50.00
"	30	Cash............	40.00			
May	3	Cash............	8.50	June 1	One month's work, May	50.00
"	15	Cash............	20.00			

An annual inventory should be taken of the farm each year. Early in the spring is usually the best time to do this. Such an inventory should list and give amounts and values of every detail of value about the farm. If the values are kept in columns so that the same page may be used for several years without having to rewrite the items, the taking of the annual inventory becomes a simple matter. The keeping of receipts and expenses is of considerable help in the farm business. It is a good practice for boys and girls to keep lists of receipts and expenses and thus form habits of thrift and economy. Moreover, because farmers do not keep accounts of expenses and receipts from their various enterprises they simply go on guessing as to what is most profitable from year to year.

2. **An account with a potato crop.** (Taken from Warren's Farm Management.)

Potatoes—1911—14 acres—(Lefthand page)

May	20	Manure 30 T. at $1.50	$ 45.00
"	23	6 oz. Corrosive Sublimate	.60
June	1	4 oz. " "	.30
"	12	6 lb. Paris Green	1.32
July	13	Seed Potatoes—160 bu. at .45c	72.00
"	13	75 lb. Arsenate of lead	6.75
"	21	50 " " " "	4.50
"	21	35 " " " "	3.15
Mar.	31	Use of land—14 a. at $5.00	70.00
		828.5 hr. man labor at 20c	165.70
		903 hrs. horse labor at 15c	135.45
		903 hrs. machinery at .05c	45.15
		Total	$549.92

Potatoes—1911—14 acres (Righthand page)

Oct.	23	226 bu. potatoes	$136.00
"	26	510 " "	316.20
Nov.	3	241 " "	261.02
March	31	Seed saved, 90 bu. at $1.00	90.00
		Saved for home use, 16 bu	9.60
		Estimated value of manure left in soil	20.00
		Total	$832.82
			549.92
		Gain	$282.90

3. **An account with chickens.**

Six Hens

May	1	Lumber for House	$3.20	May	30	Egg Sale	$ 2.50
June	2	Feed	.75	June	30	" "	1.80
"	30	Corn-meal	2.40	July	30	" "	2.10
Aug.	1	Corn	3.00	Oct.	1	Young Chicks	6.00
				Oct.	10	" "	3.00
			$9.35	Oct.	30	Eggs Used	4.00
		Profit	10.05				$19.40
			$19.40				

No special forms are needed for farm records. An ordinary account book ruled with places for dates, items, and money columns will answer. As many details as possible should be entered into the item column to make the accounts most valuable. The whole subject of farm accounts leads one easily into complexities that call for special treatment, but in this brief study the student is merely introduced to the subject and urged to adopt rational systems of accounting when he assumes the business of farm management.

1. FORM FOR FARM INVENTORY

Date..........................

Items	No.	Amount	Value
Land—acres..........			
Buildings............			
Horses...............			
Cattle................			
Hogs................			
Sheep................			
Poultry..............			
Machinery (listed)...			
Farm Crops (listed)..			

Note—Fill into above columns where the items will apply.

2. FORM FOR RECORD OF SALE OF CROPS

Date Sold	To Whom Sold	Kind of Crop	Amount Sold	Price	Total Received

3. FORM FOR ANIMALS BOUGHT AND SOLD

BOUGHT				SOLD			
Date	From Whom	Animal	Paid	Date	To Whom	Animal	Received

4. FORM FOR EXPENSE ACCOUNTS

Date Paid	To Whom Paid	For What	Amount	Price	Total

Notebook Questions

1. Why must the successful farmer be a good business man?
2. What are the sources of income for the farmer?
3. Name some of the attractions of farming as a vocation.
4. What are some of the problems of farm management most considered on your father's farm?
5. Why is it as essential in the farming business to have a good market as it is to grow the products?
6. What constitutes a good market?
7. How is the parcel post aiding the farmers in marketing?
8. Give some principles essential to successful marketing of farm produce. Criticize the markets and the marketing in your locality.
9. Why is it helpful in the business of farming to keep records and accounts?
10. What are some records and accounts the farmer should keep?
11. What is a farm inventory?
12. What records and accounts are kept on your home farm?

Practical Exercises and Home Projects

1. **Farm income.** Calculate the labor income on the following farm year records, allowing 5 per cent interest on the capital invested:

Farm contains 80 acres valued at $150 per acre.
Two horses worth $200 each.
Three milk cows worth $50 each.
Three sows worth $25 each.
Thirty pigs worth $400.
One hundred chickens worth $75.

House and farm buildings worth $4,000.
Farm implements worth $1,000.
Forty acres in corn yielding 60 bushels per acre.
Fifteen acres in wheat yielding 20 bushels per acre.
Five acres in yard and gardens.
Ten acres in alfalfa yielding four tons per acre.
Ten acres in pasture.
One man does practically all the work; there are four in the family.
Three calves are sold at $20 each.
Twenty-four pigs are sold at $250.
Fifty chickens are sold at $1.00 each.
Eggs and butter keep up the grocery bill and afford spending money for household necessities.
Four hundred bushels of corn are sold at 60 cents.
Two hundred and fifty bushels of wheat are sold at $1.00.
Twenty tons of alfalfa are sold at $20.00 per ton.
All feeds and seed are raised on the farm.

Not counting the rental value of the homestead or the value of food produced on the farm for family use, what is the farmer's labor income, after deducting 5 per cent for interest on the capital invested?

2. **Record of a crop rotation.** The following is an actual record of a ten-acre field in a four-year crop rotation.*

(1)	Clover sown in wheat in March.	
	Number of bushels	1
	Cost of seed	$6.50
	Cost of labor	1.25
(2)	Wheat cut in July. Threshed and sold.	
	Yield, bushels	200
	Value of yield	$160.00
	Total cost of labor	17.50
(3)	Pasture clover in fall.	
	Number head of stock	5
	Number of months	2
	Income from pasture	$12.00

*Taken from the Author's *One Hundred Lessons in Agriculture.*

(4)	Clover hay harvested next June.	
	Number of tons	12
	Price per ton	$ 5.00
	Cost of labor	12.00
(5)	Clover seed crop in fall. Threshed and sold.	
	Number of bushels	15
	Value of yield	$90.00
	Cost of labor	20.00
(6)	Plow and plant corn, following spring.	
	Cost of labor	$10.00
	Cost of seed (1½ bushels)	1.00
	From cultivations, cost of labor	7.50
(7)	Seeded wheat in corn, September.	
	Seed cost (1½ bushels per acre)	$12.00
	Cost of labor	4.00
(8)	Corn harvested in fall.	
	Number bushels	500
	Value of yield	$200.50
	Cost of labor	15.00

Calculate total cost and receipts of this rotation, and the net gain on one acre for one year. Is it a good return?

Arrange the items of this record into columns on the proper debit and credit pages of a book as it should appear in a bookkeeping account.

3. **The farm inventory**. Let each pupil make an inventory of the home farm and its equipment, and, after the total value of the property has been estimated, find the necessary net income in order to realize 5 per cent on the capital invested.

4. **Business forms.** Pupils should drill on the making of receipts, notes, checks, simple rent and labor contracts, and business letters.

CHAPTER XV

COUNTRY LIFE ORGANIZATIONS

An unorganized industry. If King Solomon were living today he might say, "Of the making of many organizations there is no end, and much meeting together is a weariness to the flesh." This would be true of urban life perhaps, but not of rural life, for the country people are not over-organized. It is not difficult to find hundreds of farmers within community bounds who do not belong to any organization. This ought not to be the case, for the best interests of the farmer and his community are conserved when he is living and working in coöperation with his fellows. The unorganized industries are sure to fall prey to the organized ones, and it will be an evil day for all when rural life in all its aspects becomes subservient to other organized industries because agricultural interests are unorganized and the farmers' individualistic tendencies prevail.

Organization an evidence of progress. One of the signs that any form of life is advanced in its development is its ability to coöperate in its parts and work in any organized capacity. This may be illustrated in the animal body. Note the differences, for instance, between the body of a sponge

and that of a man. The sponge is made up of cells each living a separate and independent existence, with little or no coöperation with the rest. It is a form of life poorly organized, and hence low in the scale of development. On the other hand, the body of the man is so highly organized that each cell coöperates with the others, making possible the advanced stage of development we see in the human body. This principle is true of mental life. The little child has not progressed mentally to that stage where he can coöperate with his fellows even in organized play, while the adult, because of larger growth and a more advanced stage of mental development, can coöperate in all forms of human activities. Enough has been said to show that a man or a community that does not coöperate in social activities, that is not able to work in an organized capacity, is in the sponge stage of life, or in the child stage of mental development.

Our country folks must keep pace with the progress of the century in all its human interests, and one evidence and means of such progress is the coöperation of rural forces in various country life organizations. This evidence of progress is seen now on every side, and country life organizations are forming in every state and county. The agricultural class of the high school would be taking a progressive step to lead in the organization of a Country Life or Agricultural Club in the school, using the plan suggested in the appendix of this book as a basis for organization. Such a club, organized among high-school students who are interested in agriculture and country life, would afford excellent opportunities for such training as will better fit the boys and girls to

become leaders in country life organizations when they go out to live the life of good citizens of the open country.

The Grange. One of the oldest and best rural life organizations in this country is the Grange, or the Order of Patrons of Husbandry. The idea and plan of this organization originated in the mind of Oliver H. Kelley, a Minnesota farmer, in 1867, while on a trip through the southern states. He had been sent by President Johnson to see what might be done to rebuild the devastated agriculture of that region. On his return to Washington, the organization was formed, and from that day to this the Patrons of Husbandry have extended their organization and good service to rural life into almost every state in the Union, having a membership at present of nearly a million men, women and young people.

The purpose of the organization is to promote the interests of agriculture in every legitimate and possible way, educationally, legislatively, coöperatively, and socially, with a view to developing a better manhood and womanhood on American farms.

The Grange has been an important factor in the establishment of agricultural colleges, high schools, and instruction in agriculture in elementary schools. Rural mail delivery, the parcel post, the patent-free sewing machine, the Interstate Commerce Commission, the United States Department of Agriculture, pure food laws, better tax laws, and scores of other measures of state and national value to agriculture and country life, are the products of active Grange advocacy.

It is a secret organization, and has its national, state and

subordinate chapters or granges well organized and closely bound together. The Grange is a live institution, and its growth is of a permanent character.

Farmers' Institutes. The Farmers' Institute has been in existence for over half a century and, like the Grange, has demonstrated its usefulness to country life. The Institute carries on an educational extension work. There are strong state and county organizations and national officers with advisory relationship, but there are no well-organized local community groups, meeting often as regular clubs. Most of the work is done in annual gatherings of agricultural people, and the organization offers opportunity for intercourse, for agricultural and household science instruction, for forming acquaintances, and for promoting a class consciousness. The Farmers' Institutes have popularized agricultural education, and have had a large part in the new agricultural awakening.

The American Society of Equity. This is a comparatively new organization. It was incorporated under the laws of Indiana in 1902. It has extended its membership into several states, and has had much influence in determining the prices of farm products. It has a local, county, state, and national organization. Its objects are set forth as economic, educational, scientific, protective, social, pacific, and promotive. The American Society of Equity bids fair to become a strong factor in rural life organizations.

The Farmers' Union. The Farmers' Union is an organization especially strong in the South. The organization was formed in the interests of farm life by Newt Gresham in the

State of Texas in 1902. The Union has had a rapid growth. Every southern state and many northern states have Farmers' Unions, and the organization claims a membership of nearly three million. The Union has coöperated with labor unions, and seems to have objects and aims similar to the great labor union organizations, so far as they will apply to agricultural interests. It pledges that efforts shall be made to preserve the common "rights and liberties," to give preference to the products of labor that is organized, and to have its officers coöperate with those of labor for social, legislative, and political amelioration.

Country life clubs. Under various names, such as country life clubs, farmers' clubs, agricultural clubs, community clubs, etc., rural people have formed local organizations. These organizations usually include the whole families of the farmers. They meet regularly, have programs of music, recitations, discussions of farm, home, and educational topics, and frequently lecturers from the outside are invited to take part in the programs. Various forms of refreshments are often served during a social hour preceding or following the club's program.

All such local organizations, by whatever name known, may now become affiliated with the National Country Life Club by merely notifying the secretary, who, at present, is the author of this book. Such affiliation requires no fees or obligations, but gives the local club the advantage of being united with larger groups from which it may receive inspiration and guidance through its publications. One promising development of country life clubs is the Collegiate

Country Life Club, an organization now growing in colleges, normals, and other schools, whose membership is composed of college men and women who are to become the leaders of country life institutions and interests when they leave school.

Boys and girls agricultural clubs. No study of country life organizations would be complete without looking into the growth, work, and development of the boys and girls club movement. There is a national leader directing this work, and nearly all the states have state leaders coöperating. County superintendents of schools, county agricultural advisors, and other local leaders are active in the organization and direction of the boys and girls agricultural clubs. These clubs are organized to promote better agriculture and home economics, and usually center about some form of contest. Corn-growing, tomato-raising, canning, gardening, pig-raising, and poultry-raising contests are carried on by these clubs, and the possibilities of extending their activities into all phases of farm and home life are unlimited.

Agricultural Improvement Associations. One of the latest and most efficient forms of a country life organization is the Agricultural Improvement Association, forming in hundreds of counties over the country in every state in the Union. The county is the unit of organization, and the securing of a county agricultural advisor for the Association is the first important work of the organization. A membership fee of ten dollars a year for a period of three or five years is usually required, and the membership is limited to between three hundred and four hundred persons. Farmers and business men of the towns of the county become members

of the Association. Officers are elected, constitution and by-laws are drawn up, and an advisor is employed.

The main aims of the Association, working through the advisor, are economic, looking to improved agricultural conditions; but more and more these associations are concerning themselves with the social, educational, and other rural life problems needing the coöperation which such a strong organization can render.

The county advisors usually work under state leaders, and these, in coöperation with the State College of Agriculture and the United States Department of Agriculture, tie up the whole system into one of the strongest and best financed and manned farmers' organization in the country. The passage of the Lever Bill in 1915 made available a large federal fund to be distributed to the counties organizing agricultural improvement associations, supplementing the fund raised by the farmers of the county.

Some activities of country life organizations. The history of farmers' organizations shows many lines of activities, ranging from local community coöperation in economic, social, and educational interests, to state and national influence in constructive legislation for rural progress. The following are some of the more common forms of local activities carried on by farmers' organizations:

1. Providing entertaining and instructive programs for community meetings.

2. Coöperating with the Extension Departments of Colleges of Agriculture in arranging short courses in agriculture and household science for the community.

3. Organizing and directing boys and girls agricultural clubs and contests.

4. Having farmers' picnics, fall festivals, and special day celebrations.

5. Putting on lecture courses for the community.

6. Coöperative buying of such farm supplies as limestone, rock phosphate, seed, spray material, expensive farm machinery, etc.

7. Purchasing pure-bred sires in coöperative live-stock improvement.

8. Coöperative selling of fruit, grain, hay, animals, and other farm products.

9. Improvement of roads, and the beautifying of the countryside.

10. Passing resolutions and taking united stands on questions of local, state, or national policies affecting the farmers' interests, and urging coöperative action of all farmers' organizations on such policies.

Notebook Questions

1. Why have not farmers been so well organized as men of other leading vocations?
2. What influence does a good farmers' organization have upon the progress of the community and rural life interests?
3. List the leading country life organizations.
4. What are some important benefits for country life which have been brought about through the influence of farmers' organizations?
5. How are county agricultural advisors employed, and what are some of their duties?

6. What activities have boys and girls clubs carried on in your community?

7. Why would a country life or agricultural club be a good organization for our high school?

8. Describe the aims, purposes, and work of the farmers' organizations you know most about from actual observation and contact.

CHAPTER XVI

RURAL LIFE PROGRESS

Rural institutions. Rural life progress is made in rural institutions. When we study the changes that have come about in recent years in the country, we must look into the business and social organizations, the country home, the country school, rural political life, and the country church to trace the progress made. These institutions have always existed in the country, and they must not only exist, but progress, if there is to be a permanent and satisfying country life.

The farm. The farm is a great plant, made up not only of land, plants, animals, and buildings, but of human life as well. It is an institution in itself, with its varied forms of life and activities. In a larger sense than the factories, department stores, railroads, and other great industrial aggregates, the well-organized farm is an institution demanding education, work, and management, and admitting of progress in all of its departments and aspects. The progress that must be made in agriculture to meet the demands of the farm in the twentieth century will be along the lines of permanent soil fertility, improvement of plants and animals, and the control of insect pests and plant and animal diseases. These

demands can never be met except through the application of science to the practical work of the farm.

The farm home. The life in the farm home is more intimately connected with the vocation of the bread winners than is the life in the homes where other vocations are carried on. On the farm every member of the family has a part in and knows of the daily activities of the business of agriculture. With the progress of scientific agriculture must come progress in the life of the country home. The present generation of home builders must make the country home more sanitary, more convenient, and more beautiful. There must be more adequate sewage disposal, so that filth and waste may not breed disease in the farm home. There must be more modern conveniences in the home, so that the women need not wear out their lives by avoidable drudgery. There must be more art in the country home, better books, better pictures, better music, better rural architecture, and a more beautiful countryside through the use of landscape art and the materials of nature so abundantly furnished.

The country school. Much good and a great deal of adverse criticism has been spoken and written about the country schools. We usually think of the country schools as the one-room institutions planted here and there and everywhere throughout the open country. Whatever these country schools may have been in the past, they, too, must fall in line with the progress of rural life in the twentieth century and serve a larger purpose for the people of the country. Some of the lines of progress for the country schools are the consolidation of the small districts into larger units, and the establishment

of high schools within easy reach of every farm home. All this implies more financial support, better supervision, and better instruction. Such vocational courses as agriculture, household science, manual training, business, etc., will be offered, together with such other branches of study as will give a liberal education to the boys and girls of the country. Furthermore, these schools will be in session at least eleven months in the year, and will be for all the people of the community, old and young alike.

The roads. So important are the roads to the progress of rural life that we may discuss them briefly along with other country life institutions. No arguments are needed to prove to the intelligent and unselfish mind that good country roads are essential to the progress of all rural institutions. The coming of the automobile has had much to do with the improvement of our modern roads. It remains for the present generation to begin the great work of building hard roads in every township of our important agricultural regions. Why should not every acre of land be taxed to support good hard roads, even though future generations be bonded to meet the indebtedness? Both present and future generations will profit by such public service as the building of hard roads.

Another large task for the present generation in this matter of road building is to provide a double track for all our railroads and traction lines. Such road building as here suggested may seem too momentous a task to think of, but, as compared with other large public services which our forefathers have done, such as pioneering a new country and establishing permanent institutions, the building of good roads

would be only one duty commensurate with the privileges and opportunities of the present day.

Political and social life. The progress of country life institutions depends in large measure upon the social organization and political control affecting rural life. The laws and their enforcement governing schools, roads, taxation, land, voting, and all social affairs of the country, contribute directly to the progress or hindrance of these matters touching country people. As our young men and women go out from the new country schools where they have learned to love the open country and to understand its needs and how to meet them efficiently, and where they have gained an education enabling them to stand among men of all vocations on equal terms, then voting will be more independent and intelligent, laws will be enacted and enforced giving better justice to country life interests, and political and social life will be cleaner and more elevating.

The country church. Last but not least among the number of the country life institutions to share in the progress of our century is the country church. No other institution labors so unselfishly for the conservation of all the better things of life as does the church. The country church may be dead or dying out in many places, but if rural life is to prosper, if agriculture is to become permanent, if country life institutions are to progress, then the country church must be saved, and it, too, must keep pace with the progress of the times. In this progress the country church must become a community serving institution. There should be only one country church in the community, and all the people should

unite to make it the center of the spiritual life of the community. The modern country church throws open its doors to all the people of the countryside. To it they come for education, inspiration, social culture, vocational guidance, religion, and all the good things that the Father of Life has so abundantly made possible in the open country.

Notebook Questions

1. Name the leading country life institutions.
2. What would you name as the one greatest need in bringing about the next step in the progress of:
   (a) the farm
   (b) the farm home
   (c) the country school
   (d) the roads
   (e) political life
   (f) the country church
3. Which of these institutions has progressed most and which least in your community?

PART IV

HORTICULTURE

CHAPTER XVII

FARM FORESTRY

Characteristics of trees. Trees are the most prominent and one of the most important and interesting features in the living vegetable world. Their great height, their long life, and their form distinguishes them from other plants. The single stem or trunk, which develops more strongly than the branches into which it divides and which in their aggregate make up the crown, is the tree's most characteristic form. The tree is the "whale" of the vegetable world in size, and the "man" of that world in point of highest development.

Identifying the trees. Before we can go far into the study of trees, we must be able to call them by their names. We must know them at sight as we know our friends. It may not be necessary for us to be able to tell just how we know the maple from the ash when we are children—the form, features, and general appearances will guide—but later we shall need to use a "key," based on structural features of leaves or other parts of the tree.

Life processes of the tree. The two great life processes

of the tree, as well as of all plants, are to get nourishment and to reproduce its kind. The tree gets its food from the soil, and the air through its roots and leaves. The solid food from the soil must go into solution and be carried upwards from the roots through the sap-wood to the leaves. The gas food must be taken in through the leaves. All this food, the minerals from the soil and the carbon from the air, is prepared for the different parts of the tree in the leaves by the aid of the sunlight. The prepared food is then carried downward through the inner soft bark to where it is needed to make root, trunk, branch, leaf, flower, and fruit. Girdling a tree, therefore, checks this downward flow of food and not the upward flow of crude sap.

The trees, except those of the palm tribe, grow in girth by adding ring upon ring of wood cells to their trunks and branches; in height, not by lifting the whole trunk and crown, but by adding to the tips of the twigs. Trees reproduce by seeds, sprouts, and sometimes by cuttings.

Structure. A tree, like every other living thing, is composed of tissues made up of minute cells varying in shape, size, and thickness of cell wall. The bulk of the bole of the tree is not living but dead tissue, composed of empty cells. For this reason the heart of a tree may be dead and the tree continue to live and grow. The living part of the tree trunk is on the outside of the wood, between bark and wood. The growing tissue of this live part is called the cambium. Growing cells are also grouped at the tips of roots and at the tips of the shoots. The thick outer bark of the tree is dead tissue which sooner or later loosens and sloughs off. In the center

of a young tree, and of an old tree whose heart has not decayed, is the pith, soft, thin-walled cells in which food is stored. The pith extends in radiating rays out to the bark. In a cross section of a tree we can see pith, pith rays, rings of growth, heart wood, sap wood, and bark.

Tree Societies—The Forest

Forest conditions. Trees grow together in societies and make what are known as forest conditions. The forest has a story quite different from that of a single tree. Here the trees struggle with one another for the best position, like people in a crowd jostling one another to get sight of some common attraction before them. In the forests trees struggle with each other for light, food, and foothold, resulting in the formation of forest crowns, forest trunk masses, and forest floors. The ideal forest crown has all its tree tops touching each other, so as to completely shade the ground without overcrowding any single tree; the wood mass has clear, straight boles and the maximum number to the acre; and the forest floor is rich in leaf-mold and free from grass and fire-traps.

The wood supply. The prime importance of the forest to mankind is its wood supply. Outside of food products no material is so universally used as wood. Indeed, civilization is inconceivable without an abundance of timber. Wood surrounds us on every hand as a convenience or a necessity. We require wood in the construction of our homes. It serves to ornament them, to furnish them, and to heat them. For

every hundred tons of coal mined, two tons of mining timber are needed. For our means of transportation we rely mainly on wood. Millions of telephone poles are needed to keep up our communications. The forest furnishes the wood for all the implements of the farm, and for all vehicles of transportation there. Lumber is not the only product of the forest. There is the turpentine of the pine, the paper pulp of the spruce and poplar, the tan bark of the oak and hemlock, the sugar and syrup of the maple, and the various distilled products from many other species. The alarming fact about the use of forest products is that we are using wood three times faster than it is growing.

Forest influences. In addition to serving as a great source of wood supply, the forest exerts certain influences on human interests. These are influences:

1. Upon the climatic conditions within the forest area.
2. Upon the distribution and character of the water flow.
3. Upon the mechanical condition and erosion of the soil under its cover.
4. Upon the sanitary and esthetic conditions of the people.

About the only influence the forest has upon climate is to keep it more uniform within its own limits, and to shelter our homes from storms and winds. The forest's greatest influence is upon the distribution and character of the water flow. The forest crown and floor catch and hold the rainfall, and allow it to sink slowly into the ground to supply a uniform flow in springs and streams, at the same time preventing destructive floods and excessive soil washes. The forest air and water are pure and healthful, and the tired city dweller,

as well as the free country man, may find peaceful rest and happy appreciation of nature beneath the forest's kindly shelter.

The National Forests

The conservation policy. Destructive lumbering and wastful use have wrought havoc with the forests. Forest fires have swept over thousands of acres of timber land, destroying not only the trees, both old and young, but even eating out the rich soil, the accumulation of ages. Then follow the washing away of unprotected soil on deforested slopes and destructive freshets which cover the lowlands with deposits of sand and mud. To prevent this waste of the wealth of the nation, Congress has established the National Forests. The spirit which controls the administration of these National Forests may be set forth in the words "careful use." Rangers patrol the forests to protect them from misuse and destruction. Live stock graze on the forest, but the number is limited. Water power is not cut off from use, and lumbering is carried on, but under the supervision of trained foresters, who see that all trees cut are closely utilized, that provision is made for leaving seed trees, and that the brush is properly burned so as to minimize the danger from fire.

In addition to these methods of careful usage, the national government is planting large areas of forest. Altogether, however, in this country we have planted an area equal only to the State of Rhode Island, whereas the area planted to trees should have been one hundred times greater. The forest is a very important contributor to our national wealth, and one

FIG. 34. REFORESTING A WASTE PLACE

of the chief reasons why our nation is so very prosperous is because we have been bountifully supplied by nature with timber. Hence it is the duty of every citizen to see that this great national heritage is not wasted or wantonly destroyed.

The forests of the United States. About one-fourth of the United States is in timberland. There are two great and unlike forest regions; namely, the Pacific and the Atlantic regions. All the country east of the Mississippi River was originally a vast forest of about seven hundred and fifty million acres, of which about 40 per cent has been turned into farm lands. The area to the west is almost twice as large, and into it stretch, like peninsulas, the forest mountain ranges of the Rockies and the forests of the Sierras and Coast Ranges.

The Atlantic forests are composed of a large variety of broad-leaved species, with conifers intermixed, gradually changing to the westward into prairie country. To the west of the prairie belt lie the plains and semi-arid regions, where tree growth is almost absent. Into this type of country the Rocky Mountain forests protrude. These forests are principally coniferous. Parallel to the coast from north to south extends the Pacific forest, along the mountain slopes of the Cascades, Sierra Nevada, and Coast Range. These forests have trees of most magnificent development, with only a few broad-leaved species. Here grow the famous "big trees," now rapidly vanishing before the lumberman.

From this vast forest domain the federal government has set apart nearly two hundred million acres as great national reservations. These reserves are controlled by expert foresters whose policy, as heretofore explained, is that of care-

ful usage of all the forest resources. Most of these reserves are in the far West, but since the federal government has appropriated about twelve million dollars to purchase eastern reserves, we now have some national forests in the Appalachian region.

The Farmer's Wood Lot

The farmer and forestry. Even though the national government does own nearly two hundred million acres of forest, and private and corporate interests own many millions more, the greatest bulk of forests is owned and controlled by the farmers. We must look to them for our future timber supply. Are they using and conserving wisely this great natural resource?

It is more practical and of more general value to the country that the farmer practice the principles of good forestry on his wood lot than that the government own large reservations. There are many reasons why the farmer should and could be governed by modern forestry principles in the management of his wood lot. The land is his, he has time to look after his forest, to study its needs and requirements, he needs the timber for farm operations, he can protect it from fire, preserve the young trees, and plant more as needed.

If all of the eight million farmers of this country would plant or wisely manage wood lots, the general forest conditions and the lumber supply of the country would be greatly improved. All non-agricultural lands, such as steep hillsides,

roadsides, and stream banks, should be covered with growing trees, for these places could not be used more profitably in any other way.

Planting the wood lot. The seedlings of such trees as catalpa, black locust, walnut, ash, and poplar may be purchased for small sums, and an acre of land will support from 500 to 1,000 of these trees. The trees should be planted on land prepared as if for a corn crop, and set from six to eight feet apart each way. The young trees should be cultivated for the first four or five years, or until the crowns touch and the canopy entirely shades the ground. In a comparatively short time the young forest will be full of promise, even within the lifetime of one generation.

If the farmer already has a wood lot, so much the better. His scientific forestry then will consist in cleaning out worthless, dead, misshapen, or crowded trees, and giving all valuable species every advantage of root and crown space. If fire is kept out and the grass is shaded down, the forest will naturally regenerate itself, and the farmer may use the mature trees and the thinnings from his wood lot without impairing the permanency of his forest.

The wood lot a source of supply. A good timber lot is one of the best crops a farmer can raise, and will yield good interest on the money invested. Such supplies as farm building frames, shingles, fence posts, telephone poles, fuel, taken from the farmer's wood lot, mean a considerable saving in expenditures when these necessities would otherwise have to be purchased.

Nut Crops

The nut trees. We should not continue our study of the forest without noting the importance of the nut trees. Nuts constitute a valuable part of man's food. They are rich and nutritious, and are coming more and more to occupy an important place among our articles of diet. Some of the leading varieties of nut trees are the almond, English walnut, white walnut or butternut, hickory nut, pecan, chinquapin, black walnut, chestnut, hazelnut, cocoanut, and Brazil nut.

The hickory. The shell bark and shag bark hickories furnish our best nuts. They make excellent shade trees and bear sweet and wholesome nuts. Every country boy knows how to gather hickory nuts. The hickory trees are propagated by sprouts and seeds. As a forest tree for wood supplies, the demand for hickory is very great, and the supply is fast decreasing.

The pecan. The pecan tree grows wild in many parts of our country and is being cultivated in many of the southern states. The Appomatox and Mantura are varieties of pecans being adapted successfully for cultivation in states as far north as Ohio, West Virginia, Pennsylvania, Indiana, and Illinois. Pecans may be propagated from seeds, but budding and grafting give the best results. Pecan trees begin to bear when about six years of age. The planting and growing of pecan groves is an enterprise worth trying, and certainly every farm should have a few trees for the sake of the shade and nuts they will afford.

The English walnut. This is a large tree which begins to bear profitably when it is about six years old, and continues for nearly thirty years. English walnuts are grown in Spain, Italy, France, and also in California. Successful attempts to grow the English walnut have been made in many of the southern states. A few trees are growing thriftily in West Virginia and Ohio, but, so far as the writer knows, none have yielded profitable crops.

The chestnut. The unusually large crop which the chestnut tree produces encourages us to believe that this tree is a profitable one to grow in many sections. The chestnut bark disease, now spreading throughout the eastern states, is a discouraging feature in chestnut culture. Many foreign varieties of chestnuts are being successfully grafted on native stock to the advantage of this branch of nut culture.

The black walnut and butternut. These common nuts are still great favorites among the farm supplies of nut foods. The walnut trees are rather rapid growers, and their culture is to be encouraged, not only for the nuts they afford, but for the valuable timber they produce.

The nut industry. The culture of nuts has become so important that a National Nut Growers' Association has been organized which publishes a monthly magazine, "The Nut Grower," and holds annual meetings to discuss the work of this industry. The demand for nuts in the markets of the world is growing rapidly, and the business of nut growing has become very profitable, especially in the South. Nuts are being used more and more extensively for food, particularly in the preparation of meat substitute dishes.

Trees in the Landscape

Beauty and utility. Goethe's remark, that "The beautiful must be taken care of; the useful will take care of itself," is to a large extent true to-day. The American people are slow to pay the price for beauty, especially in landscape art. We are entering upon a period, however, when the esthetic aspects of our surroundings are beginning to occupy our attention. Forestry is not an esthetic art, but an industrial one, the object of which is similar to agriculture; namely, the management of the soil for the production of wood crops. Yet the natural beauty, the sylvan charm, and the woodsy flavor of a forest readily suggest the esthetic element which stimulates our artistic sense. It will be impossible to develop a satisfactory country life without conserving the beauty of the landscape, and developing the people to the point of appreciating it.

The forest an element of beauty in the landscape. Both the artistically kept park of the city and the natural neglected forest of the open country contribute the largest element to the picture in the landscape. The forest furnishes the background against which the farm home scenes show most attractively. The broken sky-line of the trees, the variation in form and color of the leaves, the massing of shrubs at the borders of the forests, the seasonal changes of the foliage—all are details which the landscape gardener seeks to imitate in his efforts to give natural beauty to a bit of ground.

The call of the forest. People are naturally drawn to the forests for rest, recreation, and the satisfaction which its

shade and beauty afford. We seem to feel instinctively that trees must surround our most sacred things. We plant trees about our homes, we bring the Christmas tree into our Yuletide festivities; it was an ancient custom to plant a tree in honor of the birth of a child, and we often plant trees at the graves of our loved ones. As long as human life responds to the beauty of trees, our landscape art will be conserved.

Notebook Questions

1. Name the forest trees that you know at sight.
2. What are the two life processes going on in the living tree?
3. What are ideal forest conditions?
4. Name five values which forests serve.
5. What is meant by conservation of the forests?
6. What are some agencies responsible for the conservation of our forests? Which can do the most?
7. Name some practical work the farmer can do in providing a good wood lot on his farm.
8. List some good trees for farm wood lot planting.

Practical Exercises and Home Projects

1. **Identifying trees.** Let the class in agriculture take a walk with the teacher among the trees. Each pupil should have notebook and pencil. Let the teacher point out the trees and give each tree a number. Let each pupil take down the number and opposite the number write down the kind of tree he thinks it is. After naming a dozen or more trees, return to the house, or be seated anywhere, and check up

each list with the teacher's correct names. This exercise may be repeated until the pupils know all the trees in the vicinity.

2. **Reports on individual trees.** Assign to each pupil a single species of tree and require the following table filled out, from observational study:

Name of tree	Size and form	Place of growth	Condition of tree	How I know the tree

3. **Determining age of trees.** Cut cross sections of branches as large as can be conveniently obtained, and give each pupil a section. Count the rings of growth in the cross sections and note the age of the branches. Make drawings of the sections showing bark, rings of growth, and pith rays.

4. **An observational study of forest conditions.** Go with the class in agriculture to a forest. Let the pupils scatter out through the forest until no two are within fifty steps of each other. With paper and pencil let each pupil make note of the forest where he is standing, as follows:

1. Condition of crown, whether open or closed.
2. Tree-boles, whether clean, straight, etc.
3. Forest floor, whether grassy or rich in leaf mould.
4. Kind of trees.

5. **A forest museum.** Let the teacher and pupils start a little museum containing samples of forest products, collections of woods, tree seeds, and other materials derived from the forest. These specimens should be so arranged that they may be handled and passed about from pupil to pupil without injury.

6. **Determining board measure in a tree.** Measure the diameter of a tree of merchantable size, about breast high on the trunk. Determine by "guess estimation" the number of sixteen-foot logs which could be taken from the tree. Subtract four from the diameter in inches, square the remainder, and multiply the result by the number of logs in the tree. The result is the approximate B. M. (board measure) feet according to standard log rules. A rough estimate of lumber content of a given area could be worked out by this method.

7. **Map studies of forest areas of the United States.** Consult the maps of the United States in the school geographies. Note the areas mentioned above of the great forest regions of the country. Find answers from the geographies and from other sources to the following questions:

1. Where are the great lumbering sections of the United States?
2. What are the principal commercial species?
3. In what counties of your state are the forested areas?
4. What influence does the forest have upon water and soil conditions?
5. Upon what kind of regions should forests be permanently maintained? Why?
6. What is the conservation policy as applied to forests?

Note.—Send to the Forest Service, Washington, D. C., for a forest map of the United States.

8. **Reports on home wood lots.** The pupils should make a tabular report of the home wood lot, as follows:

No. of Acres	Species of Tree	Supplies taken from It	General Condition

9. **Planting a forest nursery.** The planting and care of a forest nursery by pupils of the public schools is one of the most practical forms of garden work, because trees are more permanent and require less attention than garden vegetables. Spade up a piece of ground about 6 feet by 12 feet in an unused corner of the school yard. Select a well drained site, not too sloping, with as rich a loam soil as possible. Work into the soil this fall a liberal amount of well rotted manure, and leave the ground without further preparation until spring.

In the spring, as soon as conditions will permit, the ground should be thoroughly pulverized and a seed-bed prepared for the planting. Lay off the plot in rows 12 to 18 inches apart. Such tree seeds as the basswood, catalpa, poplar, beech, chestnut, locust, oak, maple, and such others as can be obtained. may be planted in the rows of the nursery plot. During the fall gather and store the seeds. Acorns and nuts are best stored by being buried in sand in a box, sunk in the ground in a well drained place. Other tree seeds may be kept in

good condition in sacks hung in cool, dry places away from rats and mice.

10. **Setting a catalpa grove.** Either in the fall or spring plant a small catalpa grove on the school grounds or on an adjacent lot which some patron is willing to loan for that purpose. Plow up about one-tenth of an acre. Lay it off in rows both ways 6 feet apart. At the crossing of the rows plant a catalpa seedling. The plot will contain about 100 little trees. Send to Little Tree Farms, South Framingham, Mass., or to Ohio Valley Nursery Co., Lake, Indiana, for the catalpa seedlings. They will cost about 1 cent a tree. Be sure to get the catalpa speciosa, or the hardy catalpa, for the common soft catalpa is worthless as a farm tree.

11. **Description of various nuts.** Bring to class all the various kinds of nuts you can obtain and tabulate the description of each as indicated below:

Name of Nut	Size	Nature of Hulls	Kind of Kernel	Plant bearing the Nut

12. **The picture in the landscape.** Step to the door or the window of the school house with the class, and look out upon some forest. Call attention to the broken sky-line,

where the tree tops vary in height. Note the different colors of foliage and the different shapes of the trees. Observe how the trees and shrubs are massed, and how the shrubs fill up the space down to the ground. Frame with the eye a picture, bordered by sky, hill, forest, and earth, and observe how beautiful it is. Let the pupils now be seated and write a description of the picture from the details observed.

CHAPTER XVIII

FRUIT GROWING ON THE FARM

The Orchard

The home orchard. Every man who owns a home in the country owes it to his family to have an orchard. Fruit is a popular and healthful food, and every farm should provide it, both for the summer table and the winter cellar.

"The farm without its fruit orchard is like pancakes without maple syrup—possible, but not enjoyable." The farm orchard should supply the family and friends with the cheapest and most enjoyable fruit the year through, as well as with many dainty dishes the housewife knows so well how to prepare.

The farm orchard, besides providing wholesome food for the family, adds to the landscape beauty of the home grounds. The blossoming of the orchard in springtime, the rich green foliage of the summer, the ripened fruit of autumn, and the snow-covered branches of winter give to the old farmstead a perennial beauty which every country-bred boy and girl will learn to appreciate. In addition to furnishing these delights, the home orchard, unless the markets be over-stocked, may be a source of profit as well.

It is not the purpose of these lessons, however, to advise

or teach commercial fruit growing. We are justified in calling attention to the farm home orchard and in teaching every boy and girl in the schools how to select, set out, and care for an orchard, in order that every farm home may have its fruit supply. Unless the farm has a fruit orchard and a good garden, the country people are not likely to be well fed. The boys and girls growing up on a farm without its orchards and gardens are likely to grow discontented with the dull monotony of the food, work, and scenery of the old home and leave, to their own and to the farm's detriment.

General topics concerning the farm orchard. In order to have a successful home orchard the farmer must know how to care for it. He should know how to select the best site for his orchard, the trees best suited to his locality, how to set them out properly, how to prune, trim, and graft, and how to protect them from diseases and insect enemies. The fruit orchard will not "live by faith alone." Watchful, intelligent care and considerable work are required to maintain a farm orchard in first-class condition. While this is true, there are few things that bring better returns or give greater satisfaction for the labor bestowed.

Selecting the Trees

Varieties. The commercial orchardists seldom plant more than four or five varieties best adapted to their location and markets, but the farmer requires many varieties to supply the demands for fruit throughout the year. Early summer, late summer, early fall and winter, late winter and early

spring fruit, are all necessary for his table. There are hundreds of varieties from which to choose, but those varieties adapted to soil and climatic conditions should be selected. The trees grown successfuly in the community will indicate to the buyer what varieties are suitable. The personal tastes of the owner and his family will also guide in the selection of varieties.

A few of the standard varieties of fruit for the family orchards of the Middle West may be mentioned as follows:

APPLES. *Summer Varieties.*—Red Astrachan, Yellow Transparent, Early Harvest, Duchess of Oldenburg, Red June.

Fall Varieties.—Wealthy, Maiden's Blush, Fameuse, Grimes, Jonathan.

Winter Varieties.—Rome Beauty, Wine Sap, Salome, York Imperial, Willow, Stayman, etc.

PEACHES. Elberta, Champion, Crawfords Early, Crawfords Late, Heath Cling, Carman.

CHERRIES. Early Richmond, Montmorency, Dyehouse, English Morello, Tartarian.

PEARS. Kieffer, Flemish Beauty, Bartlett, Howell, Lincoln.

PLUMS. Burbank, Damson, Desota, Wild Goose, Abundance, Surprise.

GRAPES. Moore's Diamond, Niagara (white), Concord, Worden (black), Woodruff, Brighton (red).

Selecting the young trees. Much valuable advice is given upon buying at the nursery grounds, from nearby nurseries, and from carefully inspected stock, but the practical thing for the farmer to do is to order such varieties as he may decide upon from a thoroughly reliable and reputable nurseryman, and the chances are that he will get better stock than he would if he selected the trees himself. The good nursery-

man will know that the young trees should not be dug until the leaves have nearly all fallen, for this means that the buds are well ripened and that the wood is hard and mature.

Age of trees. Whether it is better to buy straight whips one-year-old or more expensive two-year-old apple trees on which the main branches are already started, is an unsettled question. Professor Alderman, Horticulturist of the College of Agriculture of West Virginia, writes on the subject as follows:

"The advantages in favor of the smaller trees are: first, cheapness; second, small root systems which will require only a small hole at planting time; third, the head may be formed at any height to suit the grower's fancy; fourth, the root systems receive less injury in digging than do those of larger trees.

"The advantages of the two-year-olds are: first, trees with well-formed heads may be selected, thereby insuring uniform and symmetrical orchard trees; second, they will probably reach bearing size a year sooner than a one-year-old tree; third, it is easier to detect crown gall or hairy root upon them than upon yearlings.

"Between the first-class trees of both ages the two-year-old are the more desirable. It is, however, sometimes difficult to get good two-year-old trees because the nursery block has been sorted over the previous year and the best trees sold as yearlings. Between a first-class yearling and a second grade two-year-old, the younger tree would undoubtedly be the better. Never buy three or four-year-old trees, because these are the culls of previous years which were so weak and small

that they had to be grown the extra season or two in order to bring them to a marketable size."

Planting the Trees

The orchard site. Before planting the fruit trees, it is evident that an orchard site must be determined upon. The foremost orchard fruit to be considered is, of course, the apple, which, in common with such other fruit as the farmer is likely to produce, requires a deep, well drained soil. Neither apples nor stone fruit will thrive in damp soil. Therefore a site should be selected for the orchard that is rich in plant-food, with good natural drainage, and as conveniently located with reference to the dwelling as possible. A gently sloping side hill is preferable, and, if it is a little stony, so much the better. It may not be tilled so easily, but the fruit will grow better. On hillside orchard sites there is good air drainage; that is, the cooler air settles to the bottom of the hill and the warmer air rises toward the top. This often prevents frost on the higher slopes.

Laying out the orchard. The ordinary apple tree when full grown requires 35 to 40 feet between rows. The trees may be set in squares or in triangles. From 25 to 40 trees may be planted to the acre, depending upon the distance apart and the method of laying out.

Planting the trees. Fruit trees may be planted either in October or April. There has been much discussion as to the proper way to prune and set the young tree. Some hold that all the tops and roots should be maintained and that the tree should be set in the same direction it formerly occupied with

reference to the points of the compass. Others say that all the branches should be cut off clean and most of the stalk also, as well as all of the roots. Common sense would suggest a middle ground. The head of the young two-year-old tree should be cut back so that three or four side limbs are left and these pruned to three or four buds. A central limb should be left upon which to form a new set of scaffolding limbs for the next season. These side branches become the scaffolds upon which the future top is formed. The roots should be pruned to six or eight inches, and all broken or injured parts removed.

If the orchard site has been put in good tilth and furrows opened up with the plow, little hand digging will be necessary. If the soil, especially the subsoil, is hard and compact, it will be necessary to loosen it up by digging a hole somewhat larger than is necessary to hold the roots of the tree. If the ground for the orchard has not or can not be plowed, holes from three to four feet in diameter and from one to two feet deep should be dug where the young trees are to be set. The holes should then be filled with good soil, and the young trees planted slightly deeper than they were growing in the nursery row. One of the main principles to observe especially in planting the tree is to have the earth *well firmed* about all the roots, leaving no air spaces. The ground about the trees should be mulched with soil and well rotted manure for winter protection, and the trunks of the little trees covered with common window screening or some other shield to protect them from mice and rabbits. No grass should be allowed to grow about the young fruit trees.

Care of the Young Trees

Pruning the young trees. In the paragraph on planting trees in the preceding lesson, the proper method of pruning the young apple tree was suggested. This pruning should be done in the spring before the leaves start their growth, whether the young trees were set in the fall or spring. The purpose of the first pruning is to restore the balance between root and top, to establish the growth near the trunk of the tree or stronger supporting scaffolds, and to form the proper height of the head. Formerly it was the practice to start the first limbs of the tree four or five feet from the ground. Today good orchardists of the East and Middle West head their trees from one to two feet from the ground. The advantages of low heading are as follows: (1) Being close to the ground the trees do not suffer as much from the action of the wind. (2) The low branches help to prevent sun-scald by shading the trunk. (3) The branches shade the ground about the tree and retard the escape of moisture. (4) Pruning, spraying, thinning, picking, etc., are carried on more easily. (5) There is less loss of fruit from windfalls.

Subsequent pruning in building the tree. The next season after setting and pruning a two-year-old tree, two or more branches will have grown from each scaffold branch left. Growth starting toward the center of the tree should be pinched off, and two or three of the year's branches should be cut back from one-third to one-half and left to form the supports for next season's growth. The central leader and its branches should be pruned as was suggested for the two-

year-old tree first set out. Continue this system of building scaffold upon scaffold of limbs around a central leader until three or four sets of limbs are formed, then the subsequent pruning should consist in removing superfluous branches, those which tend to grow crosswise, and in heading back branches which are making too great a growth. Much of the necessary training of a tree can be done during the early summer by pinching off the growths which later would necessitate heavier pruning. A moderate pruning each season is better than no pruning for two or three years followed by a heavy one which disturbs the equilibrium and starts a growth of water sprouts.

Winter protection of young trees. Sudden and extreme changes in temperature occurring during the winter often cause an injury to the bark of young trees known as sunscald. The wind often blows the trees about to such an extent that a hole is formed in the ground about the base of the tree, in which water may stand and freeze with disastrous results in some cases.

Mice, rabbits, and woodchucks cause annual and serious depredations to thousands of young fruit trees over the country.

In order to prevent losses from such causes as are mentioned above, the young trees for several years after planting should be protected by mounding and wrapping in the fall. Details of this work can not be given here, but good judgment and constant vigilance will guide the orchardist in his efforts to save young trees.

Cultivating the young orchard. The following systems

of orchard cultivation are used by fruit growers: sod culture, sod mulch, the mulch system, partial cultivation, and clean cultivation with cover crops. Sod culture is least desirable of all for young orchards, for trees do not make proper growth and are much more likely to suffer from rodent and borer injuries. Sod mulch consists in cutting the grass and leaving it under the trees. It is a little better than the first unless a good growth of grass is provided. The mulch system consists in piling about the trees any organic matter, such as manure, straw, weeds, etc., which will rot down. If a considerable amount is used, and it is not piled close up to the trunk, this system is very good. In partial cultivation the trees are set in plowed strips and the balance of the space left in sod. Clean cultivation with cover crops is without doubt the best one for the orchardist to follow. By this system the young orchard is plowed or harrowed, and a soil mulch maintained by harrowing at intervals of ten days or two weeks until the cover crop is sown. Cultivation should usually cease about the middle of July, and a cover crop of cow-peas, soy beans, clovers, or even rye may be sown.

Young trees make their wood growth during the period of cultivation, and the cover crop coming on later hastens the maturity of the wood and mulches the ground as a winter protection. When this is plowed under the next spring, the physical condition of the soil is improved and elements of fertility added and made available for the young fruit trees. It should be understood that the main purposes in cultivation are to keep the soil loose, to conserve moisture near the surface, and to facilitate fertilization.

Renovation of Old Orchards

Pruning old trees. It is interesting and proper to buy and set out young fruit trees and to care for them properly, but it is well to look to the old apple trees and peach trees on the farm. These old trees perhaps have done good service to our fathers and mothers, and are now being shamefully

FIG. 35. A WELL TRIMMED APPLE TREE

neglected, though they still try to renew their life with each coming season. Let us turn to these old trees with the same skill and labor which we are willing to bestow upon young trees, and they will repay us by abundant yields before our young trees have blossomed.

The first step in the rejuvenation of an old orchard is to cut down the tops of the old trees from one-third to one-half. The guiding principle in this rather severe operation

is to cut always just above a live limb, leaving no stub to die, and to paint over the cut surface with white lead, creosote, or any paint solution, to prevent decay. The dead and dying branches should be removed and all such branches should be cut close to the main stem from which they arise. All branches running crosswise or toward the center of the tree should be removed. The rough bark should be scraped off the trunks, and the old fashioned practice of white-washing or soap-suds-washing the trunk is not a bad one.

FIG. 36. SPRAYING LARGE TREES.

After such a severe pruning as recommended above, the new life of the tree will manifest itself in a vigorous growth of water sprouts in various places over the tree. Most of these water sprouts should be cut away the next season, except a few which should be left and pruned back to form

new branches. This method is especially successful with old peach trees.

Spraying the orchard. Perhaps the next step in the rejuvenation of the old orchard is to spray. Before the leaf and fruit buds open in the spring, the trees should be sprayed with a commercial lime-sulphur solution, diluted one gallon to nine or ten of water. This spray is effective against San Jose scale, apple scab, and several other fungous diseases living over the winter on the limbs and twigs of the trees. As soon as the apple blossoms fall, the next spraying should be given. This consists of a fungicide and insecticide combined, commercial lime-sulphur, one and one-half gallons diluted to 50 gallons with water, to which is added two pounds of lead arsenate in solution. This spray is used to combat fruit scab, blotch, leaf rusts and other diseases, as well as the codling moth and other chewing insects such as the canker worm, tent caterpillar, curculios, etc. The lead arsenate is the insecticide, and the lime-sulphur the fungicide. If this spraying is done thoroughly, it may not be necessary to spray again that season in order to secure a good crop of fruit. It is often advisable, however, to repeat the second spraying in three or four weeks, and again about the last of July to combat the second brood of codling moth. An ordinary fifty-gallon barrel spray pump for the farm home orchard will do the work well.

Cultivating and fertilizing the orchard. If the soil in the old orchard is poor and has not been cultivated for many years, a top-dressing of stable manure and lime worked into the soil will help to renew it. Many old orchards have been

successfully rejuvenated by dynamiting the ground about the old trees. If it is not practical to do this, the next best method is to use the mulch system: cut all grass, hay, weeds, etc., and pile with strawy manure under the limbs of the trees. This will help to retain the moisture and, by its decay, fertilize the soil.

Top-working the old orchard. Often the old apple trees are not of a very good variety, or there are not enough varieties to serve the best home uses. It is then possible to graft upon the tops of these old trees scions from the desired

FIG. 37. A. WAXING THE STUB

varieties. The stock upon which the graft is to be made may be from one-half to an inch and a half in diameter. This stock should be cut clean and squarely across and a cleft made down the stub to hold the scions. Scions from one-year-old branches on bearing trees of the desired variety

should be cut for graft. Two scions, each containing three buds, should be placed with the cambium layers in contact in the cleft of the stock, and the whole exposed cut surface then covered with grafting wax.

FIG. 37. B. TIPPING THE GRAFT WITH WAX

If both grafts grow, one may be removed to allow room for the other.

Types of Fruit

Tree fruits. The common farm orchard tree fruits belong to two classes: the pomaceous fruits, including the apple, pear, quince, etc., and the drupaceous or stone fruits, including the peach, plum, cherry, etc. The pome fruits contain several seeds encased in parchment-like cells in a central core. The drupe fruits contain a single seed in a single stony pit, all within the edible pulp of the fruit. The leafy parts of the flower of the pome types are borne upon the fruit. In the drupe types they are borne on the flower stem below the fruit. Horticulturists note other differences between these

two types, but these are sufficient for our purposes in school.

The apple. The apple is the most important American fruit. It may be obtained fresh and ripe throughout the whole year. The apple tree is one of the longest lived and

FIG. 37. C. THE OPERATION WAS SUCCESSFUL

largest of our fruit trees. It will begin bearing about the fifth year of its age, and if properly cared for will bear for nearly a century. It is grown in almost every part of the United States. Great improvement has been made in developing new and excellent varieties of apples since the day when all apples were small, worthless sour crabs.

The peach. The peach is one of our most delicious fruits.

The peach tree begins to bear when three or four years of age, and will bear for many years if properly cared for. The peach is not so hardy as the apple and succeeds well only in certain localities. Wherever the winter is not too cold for the trees, however, every farmer should grow peach trees enough to provide fruit for the family. The fruit of the peach is grown upon the shoots that grew the season before, while that of the apple is grown on spurs two or more years old.

Common Orchard Pests

Insect pests. Orchard trees need constant protection against harmful insects and fungous diseases. Special knowledge of each insect and of each kind of fruit is needed to combat successfully these pests. The best protection against orchard pests is given by spraying the trees with water containing some substance that destroys the pest without injuring the trees. The subject of spraying was discussed briefly in a former paragraph.

Insects injure fruit trees in three ways: by eating the foliage, by sucking the juice from the tree, and by boring into the fruit or body of the tree. The loss of our fruit each year, due to insects and diseases, runs far into millions of dollars.

Codling moth. The great arch enemy of the apple is the codling moth. The caterpillar form of this moth lives in the apple and is commonly known as the apple worm. The moth lays its eggs on the foliage in the spring a week or two after the blossoms fall, and the eggs hatch into the apple worms, which usually enter the fruit at the blossom end. The cod-

ling moth has two generations in a season, and when the worm or larva of the second generation leaves the apple, it hides for the winter in a silken cocoon, usually under the scale of the bark of the apple tree. The moth emerges from this cocoon the next spring soon after the blossoms drop. If you should look behind the loose bark of the apple tree now, you would probably find the silken cocoons of the apple worm. Woodpeckers and nuthatches find these cocoons and destroy them in great numbers. These birds should never be killed, as they are doing a good work in destroying the worms that would otherwise spoil many apples.

Curculio. Apples, plums, and cherries are often injured by an insect called the curculio. This insect punctures the skin of the fruit and lays its eggs in it. The eggs hatch into grubs that live until they are full grown. This causes the fruit to be "wormy" and to drop before ripening.

San Jose scale. The common enemy of all fruit trees is the San Jose scale. About all the structure the insect has is a long beak and a big stomach. It is entirely covered with a waxy scale, giving the branch upon which great numbers collect an ashy color. The scale insects suck the sap from the living bark and cause the tree to die. There are four or five broods in a season, and the young scales live dormant through the winter. The oyster-shell scale is common on the apple and peach tree, but, having only one generation in a season, the injury done by it is not so serious.

Yellows. The peach is subject to a disease called "yellows." This disease has entirely destroyed whole orchards of trees. No remedy is known for it but to dig out and burn

the affected trees. The flesh of peaches having this disease is usually marked by red lines or splashes beneath reddish spots on the surface of the fruit. Fruits showing these characteristics usually ripen prematurely. A second symptom, or the first in trees not bearing fruit, is the short tip growth of narrow, stiff, yellowish leaves nearly at right angles to the stem. In the final stage of the disease there is a small slender growth of all new wood, and a profusion of branchy growths in the center of the tree.

Fungous diseases. Evidences of fungous diseases may be seen in every orchard. There is the brown rot of the peach, and the bitter rot of the apple; the apple scab and blotch, dark brown or black splotches on the fruit; rusts, yellowish spots on the leaves; blight of the foliage of the apple and pear, in which the foliage appears burned; the black knot of the plum, hard, woody black knots on the twigs; the mildew of the grape, a powdery mould on the leaves; and the cankers of the branches, dead, sunken spots on the bark and sapwood of the trunk or branches. The practical way to combat these diseases in the fall of the year is to cut away and destroy all diseased parts and mummied fruit, for through them the spores will spread to infect the next season's fruit. Bordeaux Mixture and lime-sulphur are the sprays for such diseases.

Packing and Storing Fruit

In the business of fruit growing the orchardist is concerned with the picking, packing, storing, and marketing of the fruit, but the boys and girls who study these lessons will

be interested only in the operations of picking and storing the fruits on the farm.

Picking fruit. It is too often the practice on the farm to pick the apples from the ground after they have been knocked or shaken from the tree. No wonder the fruit gathered and stored by such methods fails to keep for any length of time. Where the fruit is bruised or the skin broken, the spores of the rot are sure to enter and cause the fruit to decay. All fruit to be stored or marketed should be hand-picked and carefully handled to prevent bruises and the consequent early decay. In the case of apples, it is generally best to pick them just as they have reached their full size and when they have attained their full color. The best time to pick a pear is just as soon as it reaches its full size and before it has begun to color. The pear may be taken in one hand and turned up, and if the stem snaps off from the spur the fruit is ripe enough to pick. A peach is ripe enough to pick when it is full grown and has reached its characteristic color. In the case of cherries and plums, the fruit should be picked just before it has reached the best edible condition.

How to pick the tree fruits. In picking the tree fruits it is best to use a basket fastened to the body of the picker in some way so that he may have the free use of both hands. The basket may be hung upon the ladder or the limbs by a wire hook, if the fruit does not have to be dropped too far to reach it. If the baskets are lined on the inside with thick cloth or burlap, they will be better for the purpose and save many bruises to the fruit. In picking apples it is nearly always essential to have long and light ladders with peaked

tops, which can be run up into the tops of the trees and rest against the branches. In orchards where trees are properly pruned a step-ladder is often all that will be required.

Handling the fruit. After fruit is picked it is very important that it should be kept cool and away from direct sun. Apples ripen very rapidly in the pile if they are exposed to the direct rays of the sun. The best results are obtained when apples are taken directly from the trees to a cool room and then kept in storage, where the ripening process is checked. When tree fruits are to be sold on the markets, they are usually sorted into three classes: first grade, second grade, and culls. First-grade apples are carefully placed in bushel boxes or in barrels, according to some system of packing, such as is here shown in the illustration, and sold on the markets of the world. In this lesson, however, we are concerned only with the storing of fruit in the home cellar, and not with commercial packing and storing.

Home storage of fruit. The home storage is generally a cellar, a half-cellar, or a building entirely above ground. An ordinary house cellar, if it has good ventilation and is not too dry, or too wet, or too warm, answers very well for the storage of fruit. It is best, however, both for the purpose of storage and for health, that the fruit cellar should be separate from the dwelling house.

The requisites of a good storage cellar are: protection from frost, uniform temperature at about 40 degrees, facilities for ventilation, and air moist enough to prevent evaporation. In cellars which are too dry the fruit should be left in closed packages, but if the air is moist and the temperature

low, the fruit may be packed in shallow racks or trays. It is well to go through the fruit package several times and sort out the over-ripe or decayed specimens, or they will rot and spread contamination to the rest of the package. The fruit stored in the home cellar will keep much longer and in better condition if each apple is wrapped in paper of some kind.

Notebook Questions

1. Give three reasons why a farmer should have an orchard and take good care of it.
2. List three good varieties each of apples ripening in early summer, early autumn, and for winter storage.
3. What conditions in young nursery stock should be inspected carefully before the trees are planted?
4. What are factors determining the location of the orchard?
5. How should the ground be prepared for the trees?
6. What conditions should receive special care in planting young trees?
7. Name three purposes in pruning young trees.
8. Why should a young orchard be cultivated?
9. How may an old orchard be revived and made profitable?
10. What are the sprays used and when applied for San Jose scale, codling moth, fruit scab, and rot?

Practical Exercises and Home Projects

Report on the home orchard. Let each pupil make a report on the home orchard according to the following outline, and tabulate his observations.

Name of Variety	No. of Trees	Age of Trees	Amount of Fruit Yielded	General Condition of Trees

Examining nursery stock. In time before this exercise the teacher should send to some nursery for a dozen or more yearling and two-year-old apple trees. These may possibly be obtained free for school purposes, or at a special price. Pupils should make note of at least six little trees as follows:

Length	Age	Root System	Condition of Graft or Bud	Thriftiness

Save the trees to plant for later studies.

Laying out a young orchard. Procure two lengths of common fencing wire, each 35 feet long. Fasten rings three or four inches in diameter at the ends of each wire.

Go to the school yard or adjacent field and lay out a small orchard plot, as follows:

Let two boys, one at each end of a wire, lay off a base line, six or seven lengths of the wire, driving stakes at each 35-foot point. Now let one boy hold one end of the wire over the first stake, a second boy hold one end of the second wire over the second stake, and a third boy hold the other ends of both wires, and where the ends of the wires meet a stake should be driven to locate the first tree in the second row to be planted. The boys should move down the base line, locating the trees in this triangular system in the second row, which becomes the base line for the third row, and so on until the orchard is laid out thus:

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O       O       O       O       O       O
    O       O       O       O       O
O       O       O       O       O       O
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Planting the trees. If the nursery stock has been provided, as suggested in the last lesson, the young trees should be planted by the class in one part of the school yard not used for a playground. Observe all the principles discussed above in planting these trees. If the school grounds are not large enough for this purpose, arrangements may be made to have the pupils assist in planting some trees on a nearby farm.

Pruning young trees. With specimens of young apple trees two or three years of age, either in the field or in the laboratory, practice pruning according to the principles discussed in the foregoing paragraphs.

Protecting young trees. Go with the class to a young orchard and let members of the class wrap the young tree-

trunks to protect them from winter injuries. Use cornstalks, building paper, wood veneering, window screening, or any convenient wrapping material.

Pruning an old apple tree. Go with the class to an old orchard where the trees have been neglected and have grown tall and unshapely. Let one or two boys with pruning saws go into the top of the tree and cut the limbs according to the teacher's directions. Follow the principles discussed in preceding paragraphs, and prune one tree as a demonstration.

Spraying demonstration. If the school does not have a spray pump, perhaps it could be arranged in the community for a demonstration to be given for the benefit of the class at some home orchard. Mix and apply the spray in the presence of the class as described on page 270.

Exercises in grafting. The pupils studying this lesson should either go to some tree and practice top-grafting, as suggested in the paragraph on grafting, or bring twigs of apple trees into the schoolroom and make the grafts. See various texts for full explanation of the cleft graft and of making grafting wax.

Observational studies of fruits. Let each pupil have an apple and note the following points. Write out the description.

1. The blossom end and the stem end.
2. The depression at the blossom end is called the basin.
3. Color and markings.
4. Shape and size.
5. Nature of blemishes, if any.
6. Cut through the center of the apple across the core. How many seed cells are there? How are they arranged? How many seeds in each cell? Observe the parchment-like walls of the cell.
7. Make a drawing of a cross section of the apple.

8. Make a drawing of a vertical section of the apple.

A good method of sketching the outline of the apple sections is to mark with an indelible pencil on the edge of the cut surface of the apple, and then press the cut surface down on the paper. The outline of the apple will be clearly defined.

Let each pupil examine a peach and compare its structure with that of the apple, noting the above points. Crack the stone of a peach and observe the kernel within. If practical, make similar studies of the plum, cherry, pear, and quince.

Judging apples. If you have ever visited a county or state fair, you will remember seeing the display of plates of fine apples, bearing the blue or red ribbons to indicate first and second prizes. In a plate of first-class show apples all the fruit should be uniform in size, shape, color, and absolutely free from any kind of blemish. Unless fruit has been thinned, sprayed, properly picked and handled, it is not likely that first-class apples can be exhibited.

Each pupil should bring a plate of four or five apples as nearly first-class as he can get. Arrange the plates of apples on a table before the class, and let each pupil score and mark all the plates of apples. Use the following score-card:

Owner of the Exhibit..................... Date.................

Points Noted	Perfect Score	Pupil's Score	Teacher's Score
Uniformity of exhibit...............	20		
Size of fruit.........................	15		
Color	15		
Form	15		
Quality	15		
Freedom from blemishes.............	20		
Total	100		

Orchard studies of insects and fungous diseases. If practical let the teacher and the class go to an orchard and look for insects and fungous diseases. Look under the bark and in the crevices for codling moth larvae, and on young branches for San Jose scale. Examine fallen fruit for curculio stings and apple worms. Look for apple scab, apple rust, brown rot, black rot, and other diseases. Make note of all observations and report in class for the next recitation.

FIG. 38. PACKING FOR THE MARKET

Reports of orchards of the community. Let each pupil select an apple orchard in the community and make a report based upon his study of the following points:

(a) Size of the orchard.
(b) Location, site, and topography.
(c) Number and varieties of trees.

(d) Planting plan.
(e) Soil, and soil management.
(f) Drainage.
(g) Intercropping.
(h) Fertilizers used.
(i) Pruning done.
(j) Orchard pests common.
(k) Spraying done.
(l) Estimated amount of fruit.
(m) Disposition of the fruit.

Decay in apples. Select three ripe apples of the same variety and of equal degree of ripeness and bring them before the class.

Strike against the side of one so as to bruise the surface without breaking the skin.

Bruise the second apple so that the skin is broken.

Leave the third apple uninjured.

Place the three apples away somewhere in the room where they will not be disturbed, and observe the results from day to day.

Which apple decays first?

Of what use is the skin of the apple?

Note—It should be understood that lists of trees and shrubs to be planted in special localities not having the average conditions described for the central Middle West, should be secured from the experiment station of the state wherein the school is located.

CHAPTER XIX

THE HOME GARDEN

Vegetable Gardening

Factors in locating the home garden. There are several important factors in locating the home garden. Convenience to the house is one of them. A southern or southeastern slope will give the best results with early vegetables. It should not be too steep, however, for the crops may then suffer from the drought and the heat of summer, and the land will be likely to wash. It is desirable to have lower ground below the garden in order to allow for air and water drainage. If the ground is not well drained naturally, it should, of course, be tile-drained. In a level country it would be well to provide some protection in the way of trees or buildings on the northern side. These, however, should not be too close to the garden. The kind of soil is important. With most vegetables sandy loam will give the best results. One should not despair, however, if he does not have the ideal soil, for most of the common vegetables adapt themselves to a wide range of soils. Where the slope of the site or the type of soil varies appreciably, one should plant the crops accordingly. For instance, sweet potatoes should be planted on the higher and drier places, and they do best in clay loam; watermelons like

a sand ridge; cucumbers and celery prefer the low, damp ground.

The mechanical preparation of the garden soil. The ideal garden soil preparation is to manure and plow the land in the fall. This practice will aid in rotting the manure and any other organic matter that might be turned under. It also helps to destroy injurious insects, diseases, and weeds, and to improve the physical texture of the soil. If the land is naturally loose, it need not be plowed again in the spring, especially for the early short-season crops. In such case, disking or deep cultivation will be sufficient. If the earth is tight, or even in the case of loose textured soil which has become much packed during the winter, it is better to plow again in the spring.

The seed-bed. The best way to prepare a seed-bed is as follows: first, disk and harrow; then plow, disk, and harrow in order, until the ground is thoroughly pulverized and properly compacted. A drag should be used if necessary to convert the surface to a finely pulverized condition. In this connection the compacting of the soil should be emphasized. Many people fail to work the soil sufficiently because they fear it will become packed. This is a mistake, as most plants need a somewhat compact soil in order to be able to gain a foothold. The above method will insure a fine pulverization of the soil to the full depth of the plowing, and a sufficiently compact soil as well.

Some vegetables can not be planted until May or June. In the case of land to be devoted to such crops, a shallow mulch should be maintained until planting time. This will

save the moisture and make the preparation of the soil much easier, a fact to be considered.

Fertilizing the garden. For the vegetable garden manure is the best general fertilizer. It should be applied in the fall and turned under. If, however, it is applied in the spring, it should be well-rotted manure. Rotted manure is sometimes used for top-dressing purposes for the growing crops. Lime should be used every few years, as the large amount of decaying organic matter in vegetable lands is constantly causing the formation of acids in the soil. Crop refuse, unless affected with some serious disease or insect, should always be turned under in preference to removing or burning it. The garden is a good place to burn all trash that accumulates about the yard or farm. The ashes add both potassium and lime. Any organic matter that will rot easily and quickly should be plowed under, and leaves, branches, etc. should be burned. If manure is scarce, one can grow cow-peas, soy beans, or rye to help keep up the supply of organic matter.

Commercial fertilizers can often be used effectively in the garden. For nitrogen, sodium nitrate is usually the best form. It should be applied as a top dressing to the growing plants, using 80 to 100 pounds per acre, and applying at intervals of ten days to two weeks. The nitrate should be scattered about the plants, taking care that none gets on the leaves. It should be cultivated into the soil. It may also be spread broadcast before or during a rain. The number of applications will depend upon the length of the growing season for the crop treated. In case of crops which bear fruit,

it is not well to continue the applications of sodium nitrate too long, as it may stimulate vine growth at the expense of fruit production. Dried blood may also be used as a source of nitrogen. Nitrogen in dried blood is not so subject to loss by drainage waters as that in sodium nitrate. When this is employed, it may be applied in relatively large amounts at the beginning of the season.

Steamed bone-meal is a good form of phosphorus for the vegetable garden, although the phosphorus may be supplied much more cheaply by using raw rock phosphate, providing it is applied two or three years in advance. The use of acid phosphate is more justifiable in vegetable growing where quick results are desired than in general farming, though it carries with it some acid. If lime is applied every two or three years, it will correct any acidity that may accumulate in the soil.

Sulphate of potassium is a good form of potassium. This element, while abundant in most soils, will frequently cause added yields, especially in the case of root crops. Wood ashes are always good to use, and all the wood ashes which accumulate on the farm should be carefully stored away under cover so that no leaching will occur. Wood ashes will not give better results anywhere than in the vegetable garden. Coal ashes have no value as a fertilizer, though they can often be used effectively in helping to loosen a tight soil.

Laying out the home garden. Upon the laying out of the garden will depend largely the ease of tending and the most profitable use of the land. The vegetables should be planted in long rows rather than in patches. If not enough

of one vegetable is used to plant a whole row, two or three kinds may be grown in a single row. The planting should be started on one side of the garden and should proceed across it with the season. It is hard to work up the soil if patches are left between beds of growing vegetables. The coarser crops that are cultivated with horse tools should be grouped together as nearly as possible. The finer crops that are tended with wheel hoes should also be placed together. The tall growing and the low growing crops should be grouped with their kind, so far as conditions will permit. The vine crops should be planted together. Crops that are planted at the same time and which require about the same length of season to mature should be placed together. This will allow for the best use of the land for a second crop. The matter of succession should not be overlooked. Usually the succession crops can be planted where other vegetables have been grown earlier in the season. The properly planned garden will not only be easy to tend, but will facilitate the production of crops throughout the growing season.

Selecting varieties and getting good seed. The selection of the proper varieties is one of the most important features in vegetable gardening, because, no matter how well other factors may be attended to, they may come to naught if the wrong varieties are selected. It is always best to place the main dependence upon the standard and proved varieties. "Novelties" should be used for trial only until they have proved themselves, no matter how enticing they may appear in the seed catalogs. One should pay particular attention

to selecting varieties that are adapted to the season in which they are grown; for instance, one would not want to use the same variety of sweet corn for the early crop that he would use for the main season crop.

Seeds should be purchased from a reliable seedsman, one who expects to stay in the business and who has a reputation to maintain.

Early season and late season plants. There is perhaps no feature in vegetable gardening regarding which more mistakes are made than the time of planting the various crops. Most people do not realize that the thirty or forty common vegetables which anyone can name in a few minutes were brought here from all parts of the earth, and that we can succeed in growing them here by furnishing them somewhat similar conditions to those under which they originated and developed. Naturally, coming from many widely different climates, each crop has its special temperature and moisture requirements. We recognize this tendency by growing them during a time of the year best suited to their needs, and by planting them in moist or dry locations according to their preferences. Happily, the thirty or forty different vegetables divide themselves into groups according to the temperature and moisture requirements, so that, instead of it being a problem of remembering thirty or forty different cultural methods, we may reduce the number to a very few by dividing the vegetables into groups.

All vegetables may be divided into two general groups, cool-season and warm-season groups. The cool-season crops

are those which originated in temperate climates, and the warm-season crops are those which originated in the tropical and subtropical regions.

Planting table. The following table takes into account the seasonal requirements of the various crops, and also indicates the varieties that should be planted at different times. There are other varieties which could, no doubt, be well added to this list, but those named can be depended upon in general to give satisfaction. By selecting the varieties named and planting them as nearly as possible at the times mentioned, taking into consideration the latitude of the place in which they are grown, the various vegetables can be had at all times of the year when it is possible to grow them.

Planting Dates and Varieties Recommended for Farmers' Vegetable Gardens in Illinois

By C. E. Durst, Associate in Olericulture, University of Illinois

Note—The times for planting named are especially adapted for central Illinois; in southern Illinois plant early crops from one to two weeks earlier in each case, and in northern Illinois about one week later.

Planting Dates	Crop	Varieties Suggested for Illinois Planting
Perennial Crops	Asparagus	Palmetto. (Plant one year old roots in early spring.)
	Rhubarb	Victoria or Linnaeus. (Divide old roots and plant in early spring.)
	Winter Onions	Egyptian. (Replant the sets each year about September 1.)

Planting Dates	Crop	Varieties Suggested for Illinois Planting
April 1	Potatoes	Early Ohio.
	Peas	Alaska (climbing), American Wonder (dwarf).
	Onion Sets	Yellow Bottom.
	Onion Seed	Southport Yellow Globe, Southport White Globe.
	Beets	Crosby's Egyptian.
	Turnips	Early Purple Top Milan.
	Carrots	Chantenay or Half Long.
	Parsnips	Hollow Crown or Improved Guernsey.
	Parsley	Double Curled.
	Radishes	Early Scarlet Turnip, White Strausburg.
	Spinach	Victoria or Long Standing.
	Leaf Lettuce	Black Seeded Simpson.
April 10	Radishes	White Strausburg.
	Head Lettuce	May King. (Start plants in hotbed March 1.)
	Peas	American Wonder or Gradus (climbing).
	Cabbage	Early Jersey Wakefield or Copenhagen Market. (Start plants in hotbed March 1.)
	Cauliflower	Burpee's Dry Weather. (Start plants in hotbed March 1.)
May 1	Cabbage	Early Summer. (Start plants in hotbed about March 15.)
	String Beans	Davis White Wax, Stringless Green Pod.
	Sweet Corn	Golden Bantam, White Cob Cory, White Evergreen or Country Gentleman.
May 15	Tomatoes	Chalk's Jewel, Stone, Bonnie Best. (Start plants March 1 in hotbeds.)
	Lima Beans	Henderson's Bush, Lima.
	Cucumber	White Spine or Henderson's Perfected.
	Summer Squash	Fordhook, Giant Crookneck.
	Winter Squash	Hubbard.
	Watermelons	Halbert Honey or Kleckley Sweet.
	Muskmelons	Notted Gem, Hoodo, Osage, Rocky Ford.
	Sweet Corn	White Evergreen or Country Gentleman.

Dates Planting	Crop	Varieties Suggested for Illinois Planting
June 1	Eggplants	New York Improved Purple. (Start plants in hotbed March 15.)
	Pepper	Chinese Giant, Red Cluster.
	String Beans	Stringless Green Pod, Saddleback Wax.
	Sweet Potato	Yellow Jersey.
June 15	Sweet Corn	White Evergreen or Country Gentleman.
	Late Potato	Rural New Yorker.
	Late Cabbage	Flat Dutch, Danish Ball Head.
	Cucumbers	(For pickles.) White Spine.
July 1	Celery	Golden Self Blanching Giant Pascal. (Start plants in frames about April 1.)
	Beans	Stringless Green Pod, Saddleback Wax.
	Sweet Corn	White Evergreen or Country Gentleman.
July 25	Turnips	Red Top Strap Leaf.
	Beans	Stringless Green Pod, Saddleback Wax.
August 15	Winter Radish	Chinese White, Long Black Spanish.
	Fall Spinach	Dwarf Siberian.

Seed sowing. The importance of planting good seed can hardly be overestimated. Upon the selection of the seed often depends the success or failure of the crop. The most important factors determining the quality of the seed are life and adherence to name and type. Good seed is expected to be reasonably free from weed seeds and dirt, but the grower should be sure his seed is clean before planting it. The best practice is to plant fresh seeds, preferably not more than one year old. Seeds should be stored in tight bags in cool, dry places. Successful seed sowing requires a thoroughly prepared seed-bed. The more thorough the preparation of the seed-bed, the less work is required to keep the ground in

condition during the growing season. In the home garden the seeds are usually planted by hand by dropping them in the hills or furrows previously prepared. After planting, the soil should be firmed by pressing it down with the back of the hoe. For the best and quickest results, seed should be planted in freshly prepared ground.

Advisability of the hotbed. Hotbeds are practically indispensable in the making of a good vegetable garden. Their greatest use is in starting plants for outdoor crops. By their help one can have earlier crops in the case of some vegetables, and, what is more important, he can grow some crops which could not otherwise be grown, as long season crops like eggplants and sweet potatoes, etc. They can also be used for growing such crops as lettuce or radishes to full maturity out of their season.

Principles of successful transplanting. Transplanting, while it must always be looked upon as more or less injurious to the plants, is a necessity in vegetable gardening. It is used principally for inducing earliness; it also enables us to grow such crops, for instance, as eggplants which otherwise require too long a season. After getting a good start in a hotbed or frame, plants may later be removed to freshly worked soil, without having to battle with bad weather and adverse soil conditions when they can least endure them.

The time of planting the seeds will depend altogether upon the crop grown. The operations will be facilitated if the seeds are sown in shallow flats, which may be carried about as desired. When the plants have begun to show their first pair of true leaves, they should be shifted; that is, taken up

from the seed flat and planted in other flats or in pots where they are given greater freedom. In the case of eggplants and head lettuce, which do not transplant easily, it is better to handle the plants in pots than in flats, for they transplant to the open more readily and their root system is injured less. Cabbage, cauliflower, kohlrabi, Brussels sprouts, and tomatoes can be very well handled in flats, or they may be transplanted to the open bed. Onions are sometimes started in the hotbed in order to secure a larger bulb, but they are seldom transplanted. Beets are often started in greenhouses or hotbeds by market gardeners to secure an earlier crop.

A short time previous to planting in the field, the plants should be transferred to a cold frame so that they may "harden off." A cold frame is like a hotbed with the exception that it has no bottom heat. "Hardening off" means accustoming the plants to the open weather conditions and to the relatively dry open field conditions, so that they will not suffer from the transfer to the open. The cold frame is covered for the first few nights and is left open on all except cool days. Gradually the plants are exposed to colder and colder weather, until finally the covers are left off altogether for a few days or a week previous to transplanting to the field. The plants should receive sufficient water to keep them from dying, but gradually the amount of water applied should be reduced while they are in the cold frame, so that finally they will get along with the normal rain supply.

It is always desirable to let the soil become rather dry for several days before transplanting. This, coupled with the exposure of the plants to cold nights, will harden the tissues

and fit them for transfer to the open soil. A few hours before the actual transplanting, the soil should be heavily watered. The plants, being "thirsty," will take up enough water to fill their tissues, in which condition they will be able to allow more transpiration. The plants should not be removed from the frames until the soil has become mellow. Puddling the soil by working it while wet should always be avoided. As large a part of the root system should be removed with the plant as possible, and it is well to take as much soil with the roots as will cling to them.

In transplanting plants to the field one should firm the soil about the roots thoroughly. If a plant is properly transplanted, watering in the field is scarcely ever necessary, but in the home garden one will insure a stand if he takes no chances and waters the plants. When water is applied, it is always best to pour it into a basin made about the plant, allowing it to disappear, and then covering the wet surface with mellow, loose soil.

The principal factor in causing the death of plants is an excessive transpiration from the leaves. The removal of a part of the top of the plant will reduce the transpiration and often save the plants during a dry period. Not all plants can be "sheared," but onions, beets, celery, and, to a certain extent, cabbage will allow this method. The best implement for transplanting, everything considered, is a pair of human hands. Other serviceable tools are the garden trowel, the dibber, and the spade. In commercial gardening, a transplanting machine which sets the plants as fast as a team of horses draws the machine is often used.

Thinning vegetables. Plants must have sufficient room if they are to develop properly. All excessive plants are nothing less than weeds. With many vegetable crops the planting is done in such a way as to give the plants room. Cabbage, tomatoes, sweet corn, and beans are examples. With most of the small seeded crops, however, the seeding is usually liberally done on account of the weak embryo and the susceptibility of the young plants to the weather and soil conditions. Market gardeners even go so far as to test the seeds in advance and plant accordingly, so as to insure a good stand and yet prevent overcrowding. In this way little thinning is necessary.

The vegetables commonly planted in drills in the field and which require thinning are beets, parsnips, parsley, salsify, and onions. Melons and cucumbers are often planted thickly in the hill and thinned when the plants have become well started. The thinning of plants which are started indoors and transplanted to the open field is accomplished by shifting the plants to other flats or pots, as already explained, and planting them in the field one in a place. The thinning of all crops should be done as early as the size of the plants will permit. In case of onions, since some size will be reached before the plants will pull out without breaking off, the thinning may be delayed. Thinning of the crops insures specimens of larger and more uniform size, and a much greater percentage of the product is marketable or usable.

Cultivation. The control of weeds and the provision of a soil mulch is the most important work in the cultivation of the garden. Some people even doubt if cultivation has much

value if there are no weeds. After each rain, as soon as the ground will permit, a shallow soil mulch should be made and the crust broken up.

Garden tools. Every gardener should have a wheel hoe. It will make gardening a pleasure instead of a drudgery. There are two kinds: The single wheel used between the rows, the best use of which is insured when the rows of vegetables are planted exactly parallel; and the double wheel hoe, which, like the two-horse cultivator, straddles the row and cultivates both sides at once. This is the better implement to use while the crops are small. Several attachments are provided for both types. The hoe blades can be so set that they will scrape very close to the row, killing weeds and providing a shallow soil mulch. Another attachment which comes with the machine is a set of cultivator teeth for use when the plants are larger. In the home garden it is probably not advisable to have a seed drill. This tool, while indispensable in planting an area of any considerable size to fine seed, is not so well adapted for the home garden. There is nothing better than the human hand for distributing the seeds as they should be, and there is nothing which adapts itself more easily to difference in thickness of seeding and difference in size of seeds.

The Most Serious Garden Pests

Green cabbage worm. This worm is the greatest obstacle to cabbage growing. It can be controlled early in the season with arsenical poisons, which may be used without dan-

ger to human beings. Some persons even say that it can be used after the plants have begun to head. While this view seems reasonable, it is perhaps best to be on the safe side and not use poisons after the heads begin to form. Later pyrethrum and white hellebore may be used.

Striped cucumber beetle. This pest may be controlled by applying Bordeaux mixture and arsenate of lead to the young plants. It should be applied as soon as the plants appear above ground, and plants should be kept covered on both the upper and lower sides of the leaves with this material until the vines have begun to run. For cucumbers or melons the standard Bordeaux mixture is too strong, and a mixture containing half the usual amount of copper sulphate should be used. A mixture of 4 pounds lime, 2 pounds copper sulphate, and 2 pounds lead arsenate in 50 gallons of water will not injure the plants and will effectively control the insect.

FIG. 39.
USING THE HAND SPRAY

Lice. Melon lice often destroy a melon or cucumber crop in a few days. This insect may be effectively controlled by spraying with a 40 per cent solution of nicotine sulphate, reduced to one part in one thousand parts of water. This will effectively control the lice, and will

not injure the foliage. The lice live mainly on the under surfaces of the leaves. As they do not chew, but rather get their food by sticking their beak into the tissue of the plant and drawing out the sap, it is necessary to cover their body with the material named in order to kill them. Arsenical poisons are of no help in controlling this insect. The method of applying the spray is as important as the material itself. For the best results use a Vermoral nozzle with bent shank, fastened on the end of a spraying rod. If the nozzle is worked about and between the foliage thoroughly and a fairly high pressure is maintained, the material will be thrown out in a fine spray and practically every insect on the plants will be reached.

Colorado potato beetle. Paris green, or lead arsenate, mixed with a little slaked lime, are the insecticides to use for this pest.

Flea beetles often cause serious damage to tomatoes, eggplants, and potatoes. This is a small black beetle which jumps from plant to plant when disturbed. It may be effectively controlled by keeping plants covered with Bordeaux mixture and arsenate of lead.

Cutworms. These often work serious damage in the spring of the year while the ground is still cold. It is always well to avoid planting vegetables on sod ground if possible. Sometimes manure, which has laid on a pile during the previous summer, has provided an ideal place for the cutworm moths to lay their eggs, and sueh manure often adds multitudes of cutworm eggs to the soil. If the number of plants is not too great, the cutworms can be best controlled by uncovering

the earth about the plants which have been attacked and hunting out the cutworms. Bran mixed with molasses and a small amount of Paris green placed in small pits on the higher spots of the land will often be effective as a poison bait.

Diseases. The leaf spots and fruit rots so common in vegetables are caused by fungous and bacterial diseases. Some of these can not be controlled, but most of them yield readily to systematic applications of Bordeaux mixture.

Preparing products for market. To sell garden products profitably one must know how to make them attractive to the purchaser. Products should be clean, of proper size, shape, and degree of ripeness. Those that are marketed in bunches, baskets or other containers should be uniform in these respects.

Usually there are two grades of products; fancy selected, and number one, besides culls. It should be borne in mind that number one is the lower grade. The fancy selected grade will be of proper size, color, degree of ripeness and free from blemishes. A bunch or a basket will be uniform in these respects. Size should be characteristic of the variety. A beet the size of one's head would not be graded as fancy selected. Color and shape are other characteristics which should be considered in connection with the different varieties of products. The degree of ripeness at which the products are to be packed for market will depend upon the

Note—Small fruits should be included in the garden: strawberries, blackberries, red and black raspberries, gooseberries, currants, grapes, etc., but in a course of study including so many phases of agriculture these topics can not be taken up.

distance to market. Some products which are to be shipped some distance will be picked green.

In grading products it may be well to use a typical specimen as a sample and compare others with it. The following description* of the grades of tomatoes may serve to make this point of grading clear. Fancy selected tomatoes are sound, smooth, regular in shape, free from cracks, and of such size that twelve specimens will fill one basket of a flat or a four basket crate. Number one grade is composed of sound specimens, slightly inferior to the fancy selected grade in size and smoothness, or with slight cracks about the stem which may have healed over so that there is no danger of leaking. Culls are badly cracked, rough, over-ripe or under-sized specimens. Tomatoes which are smaller than twenty to the basket would be regarded as culls.

Products which are to be bunched may be first graded and then washed after bunching. This makes handling easier. All root crops, early in the season, are bunched. Radishes (except the winter type) are bunched at all seasons. In this class are green onions, asparagus, rhubarb, kohl-rabi, parsley, leeks, celery and sometimes leaf lettuce. String, raffia and tape are used in tying. Rubber bands are often used for asparagus.

The size of the bunch will depend upon the product. Bunches of radishes may contain five or six or ten or twelve depending upon size. As a novelty, white and scarlet radishes may be arranged in the same bunch. Asparagus

*Lloyd—Productive Vegetable Gardening.

bunches should be about eight inches in length and of such circumference that the hand will go about two-thirds of the way around.

Bunches of onions will appear to better advantage if the tops are trimmed off. The tops of all small beets and carrots (in size about forty to the quart) should be left on. Later in the season larger specimens may be marketed in bulk with the tops removed.

The importance of uniformity in the appearance of such products may be demonstrated by comparing two bunches, one of which contains specimens uniform in all respects and the other, products of all sizes, colors, shapes, and degrees of ripeness.

Notebook Questions

1. What are important factors in locating the home vegetable garden?
2. What is ideal garden soil?
3. Name the steps in the preparation of a good garden seed-bed.
4. What are the best and most practical fertilizers for the garden soil?
5. State some principles to guide one in laying out the garden for seeding.
6. What shall determine the varieties and the time for planting?
7. Name the standard early season and late season vegetables.
8. What are the purposes and advantages of the hotbed?
9. What vegetables are successfully transplanted?

10. What should be accomplished in garden cultivation?
11. What are some modern garden tools?
12. List the most serious garden insect pests and diseases, and explain how to combat two of them.
13. Why should everyone have a garden?

Practical Exercises and Home Projects

The garden plans. Let each pupil carefully draw to a scale the plan of the vegetable garden as it is laid out at his home.

After this study let each pupil draw a garden plan as he would carry it out in a home garden of his own.

If it is feasible to have a school garden, let each member of the class draw a plan of such a proposed garden.

Laying out and planting the school garden. If conditions at the school are favorable to the employment of labor all through the garden season, and if sufficient land is near the school to justify such an undertaking, it may be advisable to carry on a school garden. For a high-school garden the plan of making a demonstration home garden for an average-sized family seems the best one. The garden should be planted and cared for as a class enterprise. Small fruits and ornamental planting may make the whole scheme a valuable, practical piece of work in connection with the school study of vegetable gardening. The garden should be carried on as nearly in accordance with directions and correct principles which are given in this chapter as is possible. For individual work in vegetable gardening the home project garden is to be recommended as most desirable.

Cold frames and hotbeds. Since the work with cold frames and hotbeds would come during the school season, it is advisable by all means to undertake this practical exercise at school.

Cold frames are devices for growing plants early or hardening them off for the field by making use of the heat of the sun through glass without any foundation heating. They regulate heat and moisture and protect plants from heavy wind and dashing rain. The standard size of the cold frame sash is three by six feet, and the length of the cold frame will depend upon the number of sashes to be used.

Make the frame six feet wide, eight inches high in front and twelve inches high at the back, of either one-inch or two-inch lumber. A lean-to cold frame on the outside of a building may be made by nailing a two-by-four piece of lumber against the building and constructing the frame upon it. Good garden soil will furnish the seed-bed for the plants to be grown in the cold frame.

For a permanent hotbed a pit about two feet in depth is dug and, if it is desirable to make one so large, the length may be six or nine feet, with a width of three feet—the length of a window sash to be used over it. The sides and ends of the pit are supported by a lining of plank held by corner posts. The plank frame should extend above the surface of the ground eight inches at the front and twelve inches at the back. The hotbed is heated by horse manure containing straw bedding or one-third leaves. Prepare the manure by stacking it in a compost heap, turn it over every three or four days and restack. After three or four days more, mix it carefully and spread it evenly in the hotbed pit, about fifteen inches deep. Tramp down firmly. Scatter four or five inches of good garden loam over the manure in the hotbed. Make frames for the sash and place them over the hotbed; allow it to heat up. Do not plant any seeds in it until the temperature subsides to at least 90 degrees.

Early lettuce, radishes, cabbages, tomatoes, eggplants, and other vegetables may be sown thickly in rows four or six inches apart in the hotbed, and under proper care the school

will have plants to supply the neighborhood from its own garden by the time warm weather comes.

In addition to the sash, mats of carpet will be needed on cold nights. During bright days it may be necessary to lift the sash a little to allow the hot air to escape and to give ventilation. Hotbeds should be watered in the morning on bright days.

Draw a plan of the hotbed and keep a notebook record of the work done.

Cultural requirements of vegetables. Place in the notebook the following table and fill out the cultural requirements of the standard garden vegetables grown.

Vegetables	Soil Requirements	Season Requirements	Care Requirements

Outline for studying vegetables. A better crop can be produced if the grower knows, before planting time, the soil requirements, cultural methods and harvesting possibilities of each vegetable grown in the garden.

The following outline has been prepared for this purpose. It is important that children fill out a sheet of their notebook for each vegetable to be grown. Subject-matter may

be found in seed catalogs published by local seed firms, in bulletins published by state experiment stations, in bulletins published by the United States Department of Agriculture, and in any good book on vegetable production. Frequent conversations with successful gardeners will tend to clear up some of the things that are not understood:

Outline

Name and variety of the vegetable to be planted.
Soil requirements.
Fertilizer requirements.
Method of propagation—seed, bulb, and tuber.
Seasons of planting.
Methods of planting.
1. How far apart are the rows?
2. How far apart are the plants in the rows?
3. How deep is the seed, tuber, or plant planted?
4. How many seeds are needed for 100 feet of drill?

Location of the vegetable in the garden.
1. Is the vegetable sun-loving in its habits?
2. Is the vegetable shade-loving in its habits?
3. Will the vegetable shade or crowd other vegetables?

Care of the crop.
1. How often should the crop be cultivated?
2. What is the required distance between plants for the full development of the vegetable?
3. Does this vegetable need to be transplanted?
4. Does this vegetable need to be staked?
5. Does this vegetable need to be blanched?
6. Does this vegetable need to be sprayed?
   (a) What is the purpose of the spray?
   (b) What is the best spray to use?
   (c) How often should the crop be sprayed?

Harvesting.
1. When should this vegetable mature?
2. How is it prepared for home use?

3. **What is the canning possibility?**
4. **Is there a market demand for this vegetable?**
    (a) **How should it be prepared for market?**
    (b) **What price should it bring?**
5. **What seeds can be selected for next year's crop?**
6. **How is the fresh vegetable stored for winter use?**

CHAPTER XX

THE COUNTRY BEAUTIFUL

The country's fine art. One source of genuine happiness in human life is to be able to create or appreciate some work of art. We have usually thought that music, painting, literature, architecture, etc., were the only fine arts, and that these at their best were not within reach of country people. Not only are these fine arts becoming available to country people, but the revived art of landscape gardening, coming with the development of agriculture, makes possible the use and appreciation of one of the finest of fine arts by the people of the open country.

Beautifying home and school grounds. There are a few rules agreed upon by landscape artists which will guide beginners to use good taste in planting home and school grounds. These may be called the A, B, C's of landscape gardening.

A. An open greensward in front of the house.

B. Borders and backgrounds massed with trees and shrubs.

C. Curved lines in walks, arrangement of trees, shrub masses, flower groups, and the planting of foundations.

Under A we must avoid cluttering up the green lawn with flower beds, sheared shrubs, and other artificial affairs. A single tree beautiful in itself is not objectionable on the lawn.

Under B the taller trees and shrubs must be in the rear, and the whole growth shaded down in solid mass to the ground in front, where borders of flowers may be planted. These borders may swing out in curves into the lawn.

Under C the requirements are that there shall be few straight lines in the natural landscape planting. If the walks are long enough, they should gently curve, and shrub masses may be planted in these curves. The trees and shrubs should not be in straight rows, but in masses and groups curving naturally into the lawn. The angles formed by the buildings and ground should be broken by shrubs and flower borders.

Materials to use in planting. There is little excuse for country home and school grounds being barren and unplanted when they stand in the midst of such a wealth of nature's materials for making them beautiful. Fortunately nature has aided the indolent and indifferent man in many cases by growing the trees and shrubs in abundance about his home grounds. Where such is the case he ought to be enjoined from cutting them down except to shape their arrangement in harmony with correct principles of landscape art. Where the native wild shrubs and trees grow naturally on home or school grounds, they should certainly be left, with proper arrangement and care, of course. Such native trees as the maple, the linden, the ash, the elm, the poplar, the dogwood, the horse-chestnut, and many others, and such shrubs as the wild hydrangea, the azalea, the spice-bush, the sumac, the high bush cranberry, the viburnum, the chokecherry, and the elder, may be successfully transplanted from the forests and fields to the home and school grounds.

Boys and girls coöperate. If our boys and girls will help to plant and care for trees and shrubs, they will learn to respect and wish to preserve them as useful and beautiful public property. Here, with the young folks, is the proper starting point for the conservation of our trees and the beauty of the countryside, for it is they who will have to "pay the piper" after we have had our dance.

Making a picture in the landscape. It is possible to make such use of trees and shrubs that a beautiful picture of the home grounds may be framed and enjoyed by the passers-by from the public road; furthermore, it is desirable to place the trees and shrubs about the home grounds so that attractive views from the windows and doors of the house across the landscape may be secured. In the making of the picture, the orchards, forest trees, and windbreaks make excellent backgrounds. Trees and shrubs massed at the border frame the picture, and the open greensward in front of the house makes an attractive foreground. All that is needed to complete the picture in the landscape, in addition to the use of nature's plant material, are the happy boys and girls of the home living in the midst of it.

Screening unsightly objects. There may be about the home either on the owner's ground or on that of a neighbor such unsightly objects as old barns, outbuildings, washed-out banks, gaudy signboards, etc., and these may all be hidden by the proper placing of trees and shrubs, or, if close at hand, covered by vines and made attractive.

Tree butchery. In many rural villages one sees such utter disregard for the beauty of the trees as is commonly known

as "tree butchery." Tops are taken off of trees; the limbs are cut in lop-sided fashion; long, unsightly, ragged stubs are left to die and decay; and they are otherwise mutilated by commercial interests, careless hands, and ignorant tree pruners. When people are educated to appreciate the natural beauty of trees, they will make provision through proper police force and intelligent care and management to preserve this beauty to the landscape.

Some practical planting suggestions. In the beautifying of our home and school grounds we must make use of proper methods in planting the trees and shrubs, in order that they may live and grow and contribute to the picture as we had planned. All nursery stock or material brought from the woods should be healthy and hardy, with good root system, well preserved.

In most cases it is advisable to use a liberal supply of water after the hole is half filled up, so that the soil may be closely packed about the roots. Leave the surface of the ground with a loose mulch and keep the grass from growing about the tree or shrub. The label should be removed from the plant to prevent bark binding. After planting, it is better to water thoroughly every few days than merely to sprinkle the surface every day.

Trees and shrubs will grow better if the surface of the ground about them is cultivated during the months of May and June.

Notebook Questions

1. What are the materials for the landscape artist's use?
2. Give the A, B, C's of landscape gardening.
3. What are some common violations of these rules of landscape gardening you have seen?
4. Why should country home and school grounds be well planted?
5. List the trees, shrubs, and flowers you know native to your section and suitable for planting on home grounds.
6. What is meant by a picture in the landscape?
7. What tree-butchery have you seen?
8. Describe in detail the proper method of planting a shrub.
9. Where is the proper place for flowers on the home grounds?

Practical Exercises and Home Projects

Map of school grounds. Pupils should draw a map of the school yard, designating the trees and shrubs already present, and indicating where others should be placed. Draw the map to a scale. Represent trees and shrubs by little circles numbered to correspond to a key in the margin where the planting is named.

Map of home grounds. Each pupil should draw a map of the home grounds and indicate the location of buildings, walks, trees, and shrubs. Criticise the plan according to the A, B, C's of good landscape planting.

Picture study. Let the members of the class be provided with pictures of home and school grounds, and criticise these plans according as they conform to good landscape principles. Pictures may be found in nursery catalogues, college bulletins, text-books, and garden magazines.

PART V

HOME PROJECTS

Introductory Note

Everywhere the demand is being made upon teachers of agriculture to make their work practical. The ideas of practical agriculture are generally vague in the minds of those advocating it, but they usually imply the idea of a plot of ground or a "model farm" at the school. Until our present scheme of school organization is changed, such a plan is not practical or advisable. It is altogether practical work in agriculture to learn, even from books, correct principles of scientific agriculture. To apply these principles in agricultural practice will strengthen the instruction and make the knowledge surer. It is for the purpose of making as practical as possible, for the boys and girls of the public schools, some of the principles of scientific agriculture, and of giving direct vocational value to such work, that the following home projects are outlined in detail. The topics for study relating to the projects will be found throughout the text.

At the beginning of the course in agriculture, whatever text-book may be used or course pursued, each student in the class should choose one or more of the projects and carry it through to the end of the course, or until the project is well

worked out. This should be done in addition to the regular school work in agriculture, and credit for the whole course should not be given until the student has completed his project to the satisfaction of the teacher.

A neat and accurate notebook record of the project should be kept by the student. Full directions for the field and notebook work are given with each project.

No attempt has been made to classify the projects according to the length of time required for their completion, or to rank them with any credit value which they may carry. The teacher may credit the student according to the nature of the project and the character of the work done.

Under the recently enacted Smith-Hughes Law, federal and state aid is allowed to high schools teaching vocational agriculture. One of the requirements of a school thus aided is that each pupil shall carry on a six-months' farm project as a part of his course in agriculture.

General Plan of Project Record

Each student should be provided with a large sheet of durable paper, size about 12 inches by 15 inches, upon which to make a chronological record of his project according to the plan outlined below. This should be done in addition to the records made in the notebooks as explained under each project.

(From Bricker's Agricultural Education for Teachers.)

Instructor's Record	Student ....
Date	Address ....
Project	Project, extent, size, etc........
Grade	....

Date—Month, Day	Operation or Observation, What, How, Why, etc.	Materials and Tools Used—Quantity, Cost	Labor Time Cost	Results—Immediate, Final, Production	Financial Acct.	
					Expense	Income

If the project involves the use of land, draw a map of the plot to a scale on the back of the record sheet.

HOME PROJECT 1

Poultry Raising

Plans. Select at least a dozen well-bred hens of any good egg-laying strain for this project.

Housing. Build (or equip one already built) a poultry house according to good poultry house standards. One would not desire a house smaller than 8 feet by 10 feet. One hundred hens may be housed in a building 20 feet by 20 feet. The essentials of a good poultry house are:

1. Freedom from dampness.
2. Freedom from draughts.

3. Excellent ventilation.
4. Plenty of light; cheerful surroundings.
5. Convenience.

Fence off a run and keep the chickens of this project separate from others that may be about the place. Provide a dry floor upon which straw and chaff may be placed in which the hens may scratch for their grain. Have a vessel in which to

FIG. 40. MEDITERRANEAN TYPE OF HEN

keep a constant supply of clean fresh water, a hopper of simple construction in which to keep the dry mash feed, a box of road dust for wallowing, and boxes for oyster shell and grit. All these containers should be placed high enough above the scratching floor to be free of chaff and dirt. Provide nests in darkened places, and roosting poles apart from the feeding and other portions of the house.

Feeding. Consult authorities on the feeding and care of poultry, and begin the project, giving every detail your best thought, judgment, and effort. The following are some good rations for laying hens:

1—*Grain*	2—*Dry Mash*
10 lbs. Corn	5 lbs. Bran
10 lbs. Wheat	5 lbs. Shorts
5 lbs. Oats	3½ lbs. Meat Scraps

Skimmed milk. Place the grain in the straw on the floor and the mash in the hopper. Three or four handfuls of grain to a dozen hens in the morning, and all they want at night, would be a good allowance,—that is, providing you keep the hopper full of mash to which the hens may go all the time. During the summer the ration may be reduced one-half. Steamed alfalfa hay is a good winter ration. All table scraps should be thrown to the chickens. Potato and apple parings should be ground or chopped with other succulent food and given with the table scraps. Other necessary supplements should be supplied such as plenty of clean fresh water, oyster shell, grit, charcoal, and green stuff whenever available.

Raising young chicks. If possible carry through an incubator hatch of chickens. The earlier the "broilers" can be put on the spring market, the more profitable the business. The student who undertakes this part of the project should send to the State Experiment Station for special instructions.

Allow a few of your hens to sit and hatch out broods of young chicks for your project.

Notebook Records

1. Write a brief history of the breed chosen. State why the breed was chosen.
2. Draw a plan of your house, showing all details of construction and equipment.

3. Keep accurate records of all feeds, the amount, costs, etc.

4. Keep record of all eggs produced, and their value at market prices. Let the egg-record sheet show daily yields.

5. If it is at all possible, install trap-nests, label your hens by numbers placed on leg bands, and thus keep tab of each hen's egg record.

6. Write any conclusions or remarks you wish to make about your experience in this project.

HOME PROJECT 2

Keeping Dairy Cows

Select one or more dairy cows at the home farm to use in this project. Make the following preliminary notes in the agricultural notebook:

1. The breed of the cow. A brief history of the breed.

2. The pedigree of the cow if known; some points of special interest about the past history or record of the individual cow; age, weight, and general condition.

Scoring. Use the standard score-card of the state, and carefully mark the points in judging the dairy cow you select for the project. Copy or paste the score-card in your notebook.

Shelter. Is the cow kept in a stall or given the freedom of lot and pasture?

1. The nature and condition of the pasture and feed lot.

2. Description of the barn and stall where the cow is kept, fed and milked;—size of stall, floor, feeding manger, lighting, and general sanitary conditions. Make notes on all these points. Suggest what improvements should be made.

Feeding. What has been the ration of the cow prior to the beginning of the project? What was the average amount of feed given daily? Begin the record by feeding the following ration, if practicable:

(a) Sixteen to 20 pounds of alfalfa or clover hay, 3 parts of corn or oats to 1 part bran. (Feed 1 pound of grain for every 3 or 4 pounds of milk per day.)

(b) By reference to feeding table, determine the nutritive ratio of this ration. Why is it a good one? Note and modify the above ration, if practical, to meet the conditions of the farm and community as suggested by your State Experiment Station.

Give the cows plenty of pure fresh water.

Keep a record of the amount and cost of the feed stuffs used throughout the project.

Dairy products. What was the estimated milk record of the cow when this project began?

Prepare a milk record sheet upon strong manila paper, or secure one already printed from a dairy man, and post in a convenient position near the milking place. Have scales at hand where the milk can be weighed after each milking. Provide on the sheet a place where a daily record may be kept of the value of the milk at the prevailing market price. Copy this sheet by weekly summaries into your notebook.

Make a Babcock test for the butter-fat content of the milk once a month. Take composite samples for these tests from both morning and evening milkings.

(See Warren's "Elements of Agriculture," p. 345, for details in making this test.)

Prepare a record page in your notebook giving dates and results of tests made. Let this record also show the total butter-fat content from the cow for the period of the project. Giving this butter-fat the market value of creamery butter, let the record also show the total value of the butter-fat products.

Records. Make a statement showing total costs of feeding, total returns from the products, and net profit or loss accruing during the project. The student's notebook should show all the details of this project and include accurate records of all operations. Photographs and pictures pasted in the notebook would add to its value.

WEEKLY RECORD SHEET FOR EACH COW

Days	Amount of Grain Fed	Amount of Roughage Fed	Milk Yield, lbs.	Butter-Fat, Estimated pounds	Cost of Feed	Value of Products	Gain or Loss
Monday.......							
Tuesday.......							
Wednesday....							
Thursday......							
Friday........							
Saturday......							
Sunday........							
Totals.....							

HOME PROJECT 3

Pig Raising

The Beginning. For this project the farmer should allow the student to take in charge a sow and a litter of newly-born pigs, or a gilt bred to farrow in early spring or fall.

Begin the notebook record of this project by stating how many pigs are in the litter, when they were farrowed, and to what breed they belong.

Write a brief history and description of this breed of hog.

Feeding the pigs. About the first thought one has in connection with raising pigs is that they eat.

The little pig safely born and within a few minutes sucking at a teat full of milk has made a good start in life. It is important that every pig in the litter get its stomach full of the first milk of the sow.

The brood sow should be fed in such a way as to stimulate the flow of milk. If the food is too rich, consisting of skim-milk, oil meals, corn, and the like, the pigs are likely to have digestive disorders. On the other hand, if the mother is underfed, the pigs will also suffer.

Feed the sow regularly on a moderately rich ration, such as mashes made from ground oats, shorts and bran. Sweet milk added to the above makes an excellent ration. In about three weeks the pigs may begin to nibble at their mother's food, to bite at grass, and perhaps to try to root. In one corner of the pen place a small trough for the pigs and fence it off so that the sow cannot get to it. At least twice a day, just as much sweet milk as the pigs will clean up may

be given to them. Never leave any milk to sour in the trough.

In a few days a gruel of oats and wheat middlings may replace the milk. Later, corn soaked for twenty-four hours may be placed in the trough. Never feed more than they will clean up. Pigs fed in separate places in this manner will make much more rapid growth.

If pigs are free to run on the proper pasture in connection with the above feeding, the weaning process will take care of itself and the pigs learn to "root for themselves." "Pigs in clover" are contented and happy, but hog happiness and prosperity may perhaps best be found with pastures of alfalfa, rape, and clovers. Authorities say that cow-peas supply the necessary balance to a corn ration for growing pigs. If the father will allow the boy to sow an acre of cowpeas or soy beans in May, they will have a good growth for the spring pigs by the middle of July. Proper handling from farrowing to fattening time should produce pigs weighing from ninety to one hundred and twenty-five pounds. Turn the pigs on the cow-peas or soy beans two hours a day, gradually extending the period for a week, after which they may remain in the pasture all the time. The growing ration fed before should be gradually done away with, and corn should be supplied in connection with the pasture to fatten them. One acre of the cow-peas or soy beans should supply a dozen hogs during the seventy-day fattening period, at a great saving of the amount of corn ordinarily required to fatten hogs, and the hogs will have made greater gain due to a better balanced ration. Tankage at the rate of 1 part to

10 parts of water, given once a day, is a good supplementary feed for growing pigs.

Sheltering and other care of pigs. If this project is begun in the spring, the question of housing may not be so important; however, the student should know that hogs should have shelter and that their houses should be well-ventilated, well-lighted, well-drained, and sanitary. Hogs need shelter in both summer and winter.

One individual hog house, constructed on runners so that it can be moved about, should be built for the sow and her litter in this project. The house may be A-shaped, eight feet square and seven feet high, with or without a floor. (Send for the bulletins on Portable Hog Houses, Wisconsin Agricultural Experiment Station, Madison; Illinois Experiment Station, Urbana; and Iowa Experiment Station, Ames.)

There are many pig ills and diseases likely to come to the swine herd, but it will not be practicable to discuss them or suggest any study of them in this project. Cholera is the arch enemy of the hog, but fortunately science is coming to the rescue with a serum which is very successful in rendering hogs immune from the disease. If there is cholera in your neighborhood, write to the State Veterinarian for suggestions and advice. Consult with experienced farmers on other problems connected with the raising of your litter of pigs.

Records and accounts. At the beginning of the project the student should prepare a record sheet in his notebook in which to tabulate the following records and accounts:

1. Records and Accounts in Raising a Litter of Pigs

Name and Number of Sow.

Date of Farrowing	Breed	Date First Food In Addition to Mother's Milk	Kind of Pasture, Date Turned In	Kind of House Used

2.

Estimated Weight Each Month	Money Expended In the Project. For What? Amount. Estimated Value of Food not Purchased	Money Received from Sale of Hogs	Notes

Note—For a more detailed study of the pig raising project see "Pig Raising," by Nolan and Greene, published by Row, Peterson & Co.

HOME PROJECT 4

Corn Growing

Selecting the ground. The best time to choose the plot of ground upon which the corn project is to be carried out is in the fall. Select not less than one acre of good, deep, well-drained, fertile loam soil, preferably in clover sod.

Enriching the soil for permanent fertility. If the clover crop of the previous summer has not been cut and left lying on the ground to be plowed under, apply broadcast, preferably in the fall or winter, a dressing of barnyard manure at the rate of six or eight tons to the acre.

Most soils are deficient in phosphorus. Apply in the fall or winter about two tons per acre of fine-ground rock phosphate. This should always be applied to soil containing an abundance of active organic matter such as manures or clovers, and plowed down with the organic matter.

Lime is useful in aiding decomposition of organic matter and in keeping the soil sweet. Most soils should be limed once in four or five years, at the rate of two or three tons per acre of ground limestone. The limestone may be put on the ground in the spring or fall after it is broken up for corn.

Preparing the seed-bed. Corn ground, in general, should be plowed deep and be well-pulverized. Seeds will not germinate evenly if the seed-bed is lumpy and rough. It is advisable to break corn ground in the fall, providing it is not a heavy clay soil and there is no danger of the soil washing away during the winter. Never plow a clay soil when it is

wet. Plowed land should be thoroughly disked and harrowed before planting.

Selecting, storing, and testing the seed. The only satisfactory method of selecting seed corn is the one that takes into consideration the whole plant. It is necessary to select seed corn from leafy stalks that are well developed, having the ear located just a little below the middle of the stalk and supported on a short shank which inclines the ear downward. This selection can be made only from standing stalks at ripening time. Desirable ear characteristics are described on standard score-cards and will not be given here.

In the great corn belt we are likely to get freezing weather soon after corn has matured, and ears intended for seed should be protected from frost. Corn contains considerable moisture, the germ is a living thing, and the vitality of the corn may be seriously injured if it is allowed to freeze. Corn should be stored in a dry room, out of reach of mice and rats, and where dampness or freezing will not occur.

It is a wise plan to test seed corn for vitality, or ability to grow, early in the spring before it is time to plant. One poor ear of corn spoils about one-fifteenth of an acre of the corn field. One method of testing seed corn is fully explained in Farmers' Bulletin No. 409, U. S. Department of Agriculture. Write for this at Washington, D. C. Methods are also given in the chapter on corn in this book.

Planting. Corn may be planted from the first to the middle of May, or even later. Use the best seed available.

From one and one-half to three inches is the depth to plant corn, depending on the character of the soil.

The hills should be three feet six inches apart each way. Plant three or four kernels for each hill, if the check-row method is used.

As an additional feature to this project, the student may plant an ear-to-row plot. Select from seven to ten good ears of corn and plant one row from each ear. Number each row by a stake driven in the ground at the end of the row. At the end of the season report which rows yielded most, and save the seed from these rows for next year.

Cultivation. Proper cultivation is one of the most important operations in growing corn. Weeds are removed and the surface mulch is maintained in proper cultivation.

Early rolling and harrowing before or soon after the corn comes up is a good practice, facilitating the early control of the weeds.

The soil should be cultivated as often as is necessary to maintain a loose shallow mulch of soil over the surface of the corn field. Never allow the surface to become baked or hard before "laying by." Cultivate after a rain as soon as it is dry enough to work. Care should be taken not to cultivate too deep. If the roots of corn are injured, the yield is reduced. Five or six cultivations during the season would be the minimum number to insure a good crop.

Cross pollinating. Before kernels will form in the ear, pollen from the tassel must fall on the silk of the ear. This is called pollination. A stronger strain of corn is developed when the pollen fertilizes an ear not of the same but of another stalk. If every other row in the plot from which seed is to be selected is detasseled just as soon as the tas-

sels form, there will be plenty of pollen to fertilize all the corn, and the ears on the detasseled plants will necessarily be cross pollinated and are likely to be better developed than the ears on the stalks not detasseled. The student should do this work, and select his seed corn from these detasseled rows.

Record of the project. Prepare a page in the agricultural notebook to record the work on this project as follows:

1. Area of corn plot.
2. Character of soil.
3. What crops were grown on the land the three preceding seasons?
4. What amount of manure, phosphorus, and limestone was applied? When applied?
5. When and how deep was the plot plowed?
6. Condition of land at plowing.
7. How many times harrowed?
8. Date of planting. Was seed tested?
9. Variety of corn used.
10. Distance apart of planting.
11. Number of stalks per hill.
12. How plot was cultivated.
13. Depth of cultivation.
14. How many times cultivated.
15. How many pounds of ear.
16. Number of pounds of stover.
17. Yield in bushels.
18. Rent of land at $5 per acre.
19. Cost of seed.

20. Cost of fertilizers.

21. Cost of plowing, planting, cultivating, harvesting, etc. Figure your own time 25 cents an hour and the time of the horse 20 cents an hour.

22. Total value of crop, stover, and corn.

23. Net profit or loss of the project.

24. What should be the next crop on your plot?

For fuller details on this subject, see "Corn Growing," by Nolan and Greene, published by Row, Peterson & Co.

HOME PROJECT 5

SOME INSECT STUDIES*

Provide yourself with an insect net, cyanide bottle, collecting cans, lens, and mounting boxes or cases.

To collect and preserve insects a cyanide bottle is needed. Get a wide-mouthed bottle and a good cork to fit it tightly. Put in the bottom of the bottle an ounce of potassium cyanide broken into lumps about the size of lima beans; add enough saw-dust to cover the lumps and pour in plaster of Paris, mixed to a consistency of thick cream, covering the whole with a layer about a quarter of an inch thick. In a few minutes the plaster will harden. Drop an insect to be killed into the bottle and cork immediately. The fumes of the cyanide coming up through the plaster kill the insect. (*Avoid breathing these fumes, and keep the bottle corked.*) Label the bottle and keep it away from children.

***See Hodges' "Nature-Study and Life."**

Insect mounting cases may be purchased from any scientific supply company. Cigar boxes make very good cases for mounting and preserving insects.

Equip an insect breeding cage to use in following out life histories.

Try to get the eggs or pupa of some insect hibernating in these stages during the winter to place in the breeding cage in order to begin life history studies. Make notes as tabulated below:

Name of Insect	Stage Placed in Cage	Date of Starting	Date of Next Stage Appearing	Habits and Time in Following Stages

Make collections and mount in some permanent form, such as the Riker cases types of insects from each of the seven orders of insects.

If possible, secure and equip an observation beehive.

Keep notebook record of all studies.

HOME PROJECT 6

Growing Alfalfa

The ground. Select a fertile, well drained plot of ground, from one-tenth to an acre in size, to be used for the growing of alfalfa. Some steps may be taken toward the preparation

of the ground during the fall or winter preceding the sowing of the seed.

Good drainage is essential to alfalfa culture, and this should be the first item to receive attention in the preparation of the ground.

Unless the soil is naturally rich in limestone it is well to put at least a ton of ground limestone per acre on the land to be sowed to alfalfa. This may be applied at any time.

Since alfalfa is a heavy "feeder" upon phosphorus, it is advisable to apply about a ton per acre of finely-ground rock phosphate to the land before plowing the ground in the fall or spring. Stable manure or a green cover crop should be incorporated with the rock phosphate.

The ground should be plowed deeply in the fall or as early in the spring as conditions will permit and placed in "onion bed" tilth. Two methods of procedure may here be followed:

First plan. Sow the alfalfa seed, about twelve or fifteen pounds per acre, as soon as the ground is prepared, with a nurse crop of barley, about one bushel per acre, or with the "sixty-day" variety of oats. Before the barley or oats mature in the summer they should be cut as a hay crop, leaving the field to alfalfa.

Second plan. Cultivate the ground all spring and early summer as you would a corn crop to conserve the moisture and to keep down weeds. During the last week of July or the first week in August sow the alfalfa seed.

Sowing seed and inoculating soil. In either method as mentioned above, the ground should be inoculated with alfalfa bacteria just before sowing the seed.

Procure about 200 pounds of the soil upon which alfalfa or wild sweet clover has grown and apply to each acre just before seeding. Harrow it in at once. A cloudy day is preferable for this work, since sunlight may kill many of the bacteria before they get into the soil.

Use good, clean, tested alfalfa seed, from twelve to fifteen pounds per acre. On a small plot the seed may be sown broadcast and carefully harrowed in.

Cutting alfalfa hay. The crop is harvested the second summer after planting as a most valuable hay. Three, four, or five cuttings may be obtained during a season. The hay should be cut as soon as the shoots of the new growth begin to appear at the crown of the old growth.

Notebooks records. The student should keep a notebook record of every step in the operation, recording the cost of preparation of the ground, the seed, etc., and if the project continues two summers the returns from the hay crop should be added to the record.

HOME PROJECT 7

Soil Fertility and Alfalfa

Purpose. This project contemplates the handling of one acre of land in four plots. Two of these plots are untreated, and farm manure, limestone, and phosphorus are applied to the other two. Two plots, one treated and one untreated, are sown to alfalfa, and the other two put into a rotation, only one crop of the rotation appearing at a time. Wheat, corn, oats, and clover is the rotation suggested. This may be varied to suit varying conditions. It is suggested that the

work be started with corn. Thus for the first year of work there will be two alfalfa plots and two corn plots. When the rotation is completed in two plots it is moved to the other plots, and the plots used for the rotation are seeded with alfalfa. The project is adapted for use in almost any section where limestone and phosphate may be procured. Necessarily this project requires several years of time and a continuous policy of management.

THE PLAN

1. **Seeding alfalfa.** The alfalfa may be sown in the spring with a nurse crop of oats or barley, or the ground may be plowed and cultivated until June, when the alfalfa may be sown. Another plan is to sow winter rye in the spring as a nurse crop. This ceases to grow after a time and the alfalfa gets ahead of it. Another advantage of this latter plan is the fact that if the first stand is lost, the alfalfa and nurse crop may be plowed up in May and the alfalfa reseeded alone in June.

2. **Preparation and treatment.** Farm manure and steamed bone-meal or rock phosphate are applied before plowing, disked in, and plowed under.

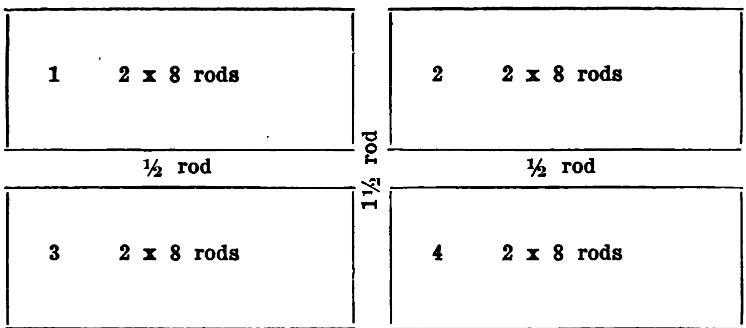
3. **Limestone.** This should be applied after plowing, and worked into the surface soil by disking and harrowing before seeding the alfalfa or planting the corn.

4. **Amounts to apply.**

Farm Manure....................	10 tons per acre
Steamed Bone-meal...............	1 ton per acre *or*
Rock Phosphate..................	2 tons per acre
Limestone.......................	5 tons per acre

5. **Inoculation.** The glue method of inoculation is advised. Both alfalfa plots are to be inoculated.

6. **The plots.** The plots are four in number, arranged as below:



The treatment of each plot is as follows (use one-tenth the amount suggested above on each plot):

1. Nothing.
2. Manure, limestone, and phosphorus.
3. Nothing.
4. Manure, limestone, and phosphorus.

The division strips are for protection, turning with machinery, etc.

The acre selected should be so far as possible representative of the farm. It should be free from draws or hillsides, and should not contain old feed lots or stack bottoms where soil is unusually fertile.

7. **Farming operations.** No directions are given for farming operations; the student is to be governed by the best farming practice in his neighborhood or on his farm. The

crops should be seeded, cultivated, and harvested according to best scientific practices.

8. **Weighing.** It is of great benefit to have scales available for use on the farm. Bone-meal may be purchased in 200-pound bags, and manure and limestone may be estimated by the wagon load or fraction thereof. This should only be done when it is impossible, without inconvenience, to gain access to scales.

9. **Sign boards.** For the benefit of visitors it is well to have small sign boards for the plots to indicate the treatment. Use these abbreviations:

O—No treatment.
MLP—Manures, limestone, and phosphate.

Still other sign boards might be made on which could be tacked cardboard bearing the yields of crops the previous year.

10. **Reports and general information.**

Name.................................... Age...............
Location—County... Township... Range... Section... Quarter...
Topography of land—Rolling, level.
Soil Type:
Surface—
Subsoil—
Drainage—Natural, open ditches, or tile drains.
Location of Plot on Farm—
Is it representative of the entire farm?
(Try to avoid abnormal spots which are not representative, such as stock bottoms, hog lots, feed plots.)
Previous History of Plot—State what crops have been grown, rotations practiced, cornstalks burned or plowed under, manure or fertilizers applied.

Is your land weedy?
State when you plowed the ground and applied the limestone, manure, and phosphorus.
Method of inoculation used? When alfalfa was sown?
What is rotation you intend to follow on plots 2 and 4?
Difficulties.

Directions for keeping records. A book about five by seven inches, ruled in squares, is recommended for this purpose, although any book may be used. On the third page of the book make a drawing of your acre showing the arrangement of the plots, and number them as in the diagram under paragraph 6.

On page 5 of your notebook rule up columns as indicated below, and record the various amounts applied to each plot. Thus:

Plot	Manure	Limestone	Rock phosphate or bone-meal	Crop
1				
2				
3				
4				
5				
6				
7				
8				

Page 7 of your book should contain a record of the hay, grain, and straw cut from each plot. Record each cutting separately, if possible. A sample form is here given:

Plot.	Pounds hay per plot.	Tons hay per acre.	Pounds grain per plot.	*Bushels grain per acre.	†Pounds straw, stover, or fodder per plot.	Tons straw, stover, or fodder per acre.
1						
2						
3						
4						

*State pounds per bushel used.
†If you are unable to get weights, omit these columns.

On pages 9, 10, and 11 keep an account of the labor expended on your acre. It should be given in boy-hours, man-hours, and horse-hours. By one boy-hour is meant the labor performed by a boy (10 to 18) working for one hour. A team of horses working for one hour performs two horse-hours of labor. A specimen page is here given:

Date.	Operation.	Boy-hours.	Man-hours.	Horse-hours.
July 10	Raking hay	2		4

Hours are to be added up at the close of the season.

On pages 2, 4, and 6 of your notebook you should keep a diary of your operations, giving such information as dates of plowing, harrowing, and seeding, conditions of weather, names and comments of visitors, appearance of alfalfa and other crops from time to time.

On pages 12 and 13 a financial statement for the year should be made out. The following form should be followed:

Page 12

Dr.

Rent of land............................				......
Cost of seed.............................	bushel	@	....	......
Cost of manure...........................	5 tons	@	$2.50	......
Cost of limestone........................	2½ tons	@	....	......
Cost of bone-meal........................	½ ton	@	....	......
Labor boy-hours		@	.25	......
man-hours		@	.30	......
horse-hours		@	.20	......
Total				......

Page 13

Cr.

Value of rotation crop..............bushels		@	....	......
Value of nurse crop................bushels	oats / barley / rye	@	....	......
Value of alfalfa hay................tons		@	....	......
Total				......

	Plots	1	2	3	4
Value of Crops......					
Cost of Crops.......					

	Value of Crops	Cost of Crops
Treated Plots..................	....	....
Untreated Plots................	....	....
Value of Increase.............	....	....
Cost of Increase..............	....	....

HOME PROJECT 8

Vegetable Gardening

Location, size, and plan for the garden. For this project the student may choose an area for his garden apart from the family garden, or he may take over the home garden and manage it as directed herein. No definite size can be required for the garden in this work, but it should be at least 32 feet by 32 feet.

Make a plan of your garden in your agricultural notebook. Draw it to a scale, about one-eighth inch to the foot.

SUGGESTIVE GARDEN PLAN

Sweet Potatoes	
Melons	Cucumbers
Sweet Corn and Beans	
Sweet Corn and Beans	

Tomatoes	
Early Cabbage	Late Cabbage
Bunch Beans	
Peas	
Beets	Turnips
Lettuce	Spinach
Onion Sets	Radishes

If your garden site is of a different size and shape than the above, follow a similar arrangement of planting, giving more or less space to each vegetable as the tastes of the family require.

Draw the plan of your garden as you plant it.

Preparation of ground. The ground should be cleared of all coarse refuse from the preceding crops, heavily manured, and deeply plowed in the fall. Forty tons of manure to an acre is not too much to apply if maximum crops of vegetables are to be grown. If the plowing is deferred until spring, fine, well-rotted manure should be used. If the soil is a stiff clay, it may be improved by the addition of sand.

Apply strips of blue litmus paper to moistened lumps of the garden soil. If the paper turns pink or red, the soil is sour and needs lime. Apply from 2,000 to 4,000 pounds per acre of air-slaked lime. Ground limestone may be used if available.

After the ground is plowed, it should be harrowed and reharrowed until the soil is crumbled into as fine a seed-bed as it is possible to make. Sow broadcast over the ground bone-meal at the rate of 300 pounds per acre.

Mark off the rows according to the plan of seeding as shown on your map, and prepare to plant the seed.

Selecting and planting the seed. For a small garden, seeds may be purchased at the local stores. Be sure that the seeds are fresh.

Much depends upon the variety of seed as to the value of the garden product. The following varieties are recommended:

Beans. Stringless Green Pod, Henderson's Bush Lima, Lazy Wife's Pole Bean for the corn.

Beets. Crosby's Egyptian.

Cabbage. Jersey Wakefield, Savoy.

Sweet Corn. Golden Bantam, White Cob Cory, Stowell's Evergreen, Country Gentleman.

Cucumber. Emerald, White Spine.

Lettuce. Hanson, May King, Morse.

Muskmelon. Netted Gem, Rocky Ford.

Onion. Southport Yellow Globe, Prize Taker.

Peas. Alaska, American Wonder, Gradus.

Radish. Earliest White, Scarlet Button.

Spinach. Long Standing, Victoria.

Sweet Potato. Nansemond.

Turnip. Purple Top Strap Leaf.

Tomato. Chalk's Early Jewel, Ponderosa, Stone.

See planting list given in the chapter on *Gardening,* page 292.

The time and methods of planting are shown in the following table:

Seeds.	Time.	Distance from preceding row.	Distance apart in row.	Depth of planting.
Beans	After frost dangers	2 ft.	3-4 in.	2 in.
Beets	Early	18 in.	3 in.	1 in.
Cabbage	Early	3 ft.	2 ft.	Transplant
Sweet Corn	Early	3 ft.	2½ ft.	2 in.
Cucumber	After frost	4 ft.	4 ft.	½ in. 6-8 seeds
Lettuce	Early	1 ft.	½ in.	¼ in.
Melons..........	After frost	4 ft.	4 ft.	1 in. 6-8 seeds
Onion Sets	Early	1 ft.	3 in.	2 in.
Peas	Early	2 ft.	1 in.	2 in.
Radish.........	Early	1 ft.	1-2 in.	1-2 in.
Spinach........	Early	1 ft.	1-2 in.	1-2 in.
Sweet Potato ...	After frost	3 to 4 ft.	12-16 in.	Transplant on ridge
Turnip.........	Early and late	2 ft.	3-4 in.	1-2 in.
Tomato	After frost	4 ft.	3 ft. 4 in.	Transplant

Firm the earth well over all seeds planted.

Students doing the vegetable garden work may be able to procure their transplants of cabbage, tomatoes, and sweet potatoes from those having the project with tomatoes and the hotbeds.

It would be well to sow seeds of some annual flowers about the borders of the garden, such as cosmos, dwarf sunflowers, etc.

Care and cultivation of the garden. The first attention to be given the garden after seeding will be to keep down the

weeds. It may be necessary to pull many weeds by hand, but whether by hand or hoe, the weeds must go.

A loose, shallow surface soil mulch should be maintained at all times. As soon after a rain as the ground is friable the surface should be broken and the mulch provided to prevent excessive evaporation. Every few days, whether it rains or not, the ground should be stirred and the growth of weeds checked. The best tool for this purpose is a wheel hoe. The Planet Junior wheel hoe is an excellent implement for every garden of the size recommended in this project. It will always be necessary for the best results, however, to use the common hand hoe in addition to the wheel hoe to put on the finishing touches.

Where some of the plants are crowding each other too much it may be necessary to thin them.

Some of the plants of the garden will need special handling as the season advances. Tomatoes should be tied up to stakes; beans, if of the pole variety, will need staking.

Combating pests will be an early problem.

1. The striped melon beetle will attack the cucumbers and melons as soon as they appear. If there are only a few hills, it is practical to protect them by covering with small screen-covered bottomless boxes. Tobacco dust, lime, etc., are repellents often successfully used.

2. Large insects, such as tomato worms, squash bugs, and various caterpillars may be picked off by hand and killed.

3. For small leaf-eating insects, such as cabbage worm, potato bug, etc., a solution of lead arsenate (about a teaspoonful to a gallon of water) sprayed upon the plants is

effective. An atomizer or sprinkler may be used in a small garden.

4. Plant lice may be combated with Tobacco Concoction, or "Black Leaf 40."

5. Ordinary blights and rots of the garden may be successfully combated by the use of Bordeaux mixture.

To utilize the garden intensively, such crops as peas, radishes, lettuce, turnips, etc., maturing early, should be removed and followed by a succession crop of the same or another vegetable.

Keeping garden accounts and records. Prepare a page in the notebook and keep records as called for in the following table:

Date of planting.	Varieties.	Up—Date.	Blooming—Date.	Used—Date.	Continued bearing.

Prepare an account sheet in your notebook as follows, and keep record of expenses and receipts:

Date.	Paid out.	Date.	Received.
April 1	For fertilizer ...$1.20		
April 10	For seeds .... .75	May 1	For dozen radishes.$0.15

HOME PROJECT 9

Tomato Raising

Early in the spring, or perhaps in February, send to a good seed house for tomato seeds. Get at least two varieties—Chalk's Early Jewel, Livingston's Globe, Matchless, Stone, Earliana, or Ponderosa.

Making the hotbed. Select a place at the south side of some building for the hotbed. Dig an oblong space, three feet wide, six feet long, and eighteen inches deep. Make a wall of posts and boards fitting close to the side of the beds, or, perhaps better, make a bottomless box to fit into the bed. Make the back wall three feet high and eighteen inches above the surface of the ground. A two-by-four set in from back to front across the middle will make a support for the window sash which is to cover the bed.

The heat for the hotbed is commonly supplied by the fermentation of horse manure. The manure from livery stables is usually best. Perhaps as much as half of the whole mate-

rial should be of litter or straw that has been used for bedding. To allow fermentation to take place, the manure should be piled for several days before using. In cold weather, wetting the pile with hot water will hasten fermentation. In order to make fermentation uniform, the pile should be turned occasionally and the hard lumps broken up. When the pile is steaming uniformly throughout it is placed in the hotbed. Fill in about nine inches of the manure and tramp down firmly; then add a second nine inches and firm as before. Now spread three or four inches of rich garden loam over the manure and the bed is ready for the seed.

Planting the seed and caring for the seedlings. Mark off the seed-bed in rows across the short way, about four inches apart. Drop the seed in the furrows about an inch apart, cover with about a half inch of soil, and firm it well over the seed. Other vegetables, such as cabbage, eggplant, sweet potato, etc., may be planted in the hotbed. Cover the hotbed with the window sash. See garden project for varieties.

The soil should be watered every few days, and on bright, warm days the sash should be raised to admit fresh air to the seedlings.

Preparation of ground in the garden. The plot of ground for the tomatoes may be plowed either in the fall or the spring. It would be well, unless the ground is especially rich, to turn under a layer of well-rotted stable manure on the tomato plot.

Harrow down the surface well and lay it off in rows four feet apart. A mixture of steamed bone, dried blood, and potassium sulphate is a good fertilizer. A shovelful of well-

rotted manure applied in each hill and covered with earth will promote growth.

Transplanting the seedlings into the garden. After all danger of frost is over, go over the tomato plot again, preparing a clean, loose surface, and renewing the rows where the plants are to be set.

Select the healthiest, stockiest tomato plants from the hotbed to transplant. Do this work in the evening to prevent excessive wilting. Have a plant trowel to dig up the seedlings with as much of the root-system as possible. The trowel may also be used to dig out the hole in which to set the young plants in the rows in the garden.

Setting the tomato plants. Place the varieties together. Using the trowel, prepare a place for each plant a little deeper than it grew in the hotbed. The old garden practice of pouring about a half-pint of water about the roots of the seedling, just before the last bit of soil is placed about the plant, is a very good plan, especially if the soil is a little dry. Firm the soil well about the roots and have a loose mulch over the surface about the tomato plant. Set the plants about three and a half feet apart in the row.

Tomato plants may be sold if a market is found.

Cultivating, pruning, and staking. Employ two methods of soil culture on your plot after you have cultivated the ground and kept down the weeds for a few weeks. On a part of your plot cover all the ground with a mulch of straw; on the rest continue cultivation to keep down weeds, and to provide a loose soil mulch at all times.

On the straw plot allow the tomatoes to fall down and grow at will without further care in pruning or staking.

On the cultivated plot, after the tomato plants begin to send out branches from the angles of the leaves, drive a stake about five feet long, containing two or three cross-arms, by each plant, and tie the plant to this stake as it grows, to keep it off the ground. Select a few plants to prune. Throughout the summer, watch the plants and pinch off all side branches, leaving only the central one to grow and be tied to the stake.

On a few plants hand methods of fighting insects may be employed. Cut-worms may be prevented by wrapping a piece of heavy paper around the stem of each plant at the time of transplanting. Tomato worms may be picked off and crushed under foot. If leaf blight or tomato rot appears, the plants should be sprayed with Bordeaux mixture.

The last work of the project would consist in keeping a record of the amount of tomatoes harvested from the plot. If the tomatoes are sold, they should be carefully graded and sold in baskets, twelve in each.

Notebook records. The student should keep a diary record of every operation performed in connection with this project.

HOME PROJECT 10

POTATO RAISING

Where to plant. Select a deep, rich, sandy loam soil, if possible, in which to grow potatoes. The plot for this project should contain at least one-tenth acre. Almost any soil, how-

ever, that is warm, mellow, and contains the requisite plant food will produce good crops. It would be well to enrich the soil with well-rotted manure the fall previous to planting.

Preparing the seed-bed. All potato soils should be made mellow to a good depth. It is best to plow up the ground in the fall before the winter rains and snows begin. Frequent harrowings in the spring up to planting time will conserve moisture, produce good tilth, and keep down the weeds.

Sow bone-meal fertilizer broadcast over your potato plot at the rate of 300 pounds per acre, and harrow it into the soil before planting.

Seed potatoes. Such varieties as Early Rose, Early Ohio, Carmen No. 3, The Burbank, etc., are standard varieties to plant.

Seed potatoes should not be smaller than a hen's egg, and from that up to six ounces in weight. When potatoes are cheap it will pay to plant medium-sized, whole tubers. Seed potatoes should be smooth and free from scab and warty spots.

Treatment for scab may be necessary to insure a good crop. This disease causes rough, warty spots on the tubers. Tubers should be treated in the following way before planting: Add one ounce of formalin, which may be obtained at any drug store, to each two gallons of water used. Place uncut seed potatoes in a bucket or tub and cover them with the diluted formalin solution. Allow the tubers to soak for two hours, then spread out to dry until planting time.

Cutting the tubers. If only small-sized tubers are used it will not be necessary to cut them. When large tubers are

used they should be cut into halves or quarters longitudinally. Cut from the eye-end toward the stem-end, leaving at least one of the "seed end" buds on each piece. Do not cut the tubers until ready to plant.

Planting the tubers. Potatoes may be planted in April or May, without reference to the moon or Good Friday. Early potatoes should be planted as soon as the ground can be worked and the danger of freezing is past.

Depth and distance apart. Depth and distance between potatoes in planting depend upon soil conditions and variety. In general potatoes should not be planted less than three inches nor more than eight inches deep. In good soil potatoes may be drilled one foot apart, one piece to a place in the row, or, planted in hills, two pieces to a place about fifteen inches apart in the row. (Use both methods.) The rows should be two or three feet apart, depending upon the method of cultivation used. A peck of seed to a 100-foot row is the amount usually required. Plant in straight rows and cover with moist earth as soon as planted.

As an experiment, plant one row on the surface of the ground and cover the potatoes and the ground for two feet on each side of the row with old straw. Give no further cultivation to this row.

Cultivation. If the seed-bed has been well prepared, it will not be necessary to stir the ground until the plants appear. If a crust forms after planting, it should be broken with a harrow or a rake. As soon as the plants are up so that the rows can be seen, give them a good cultivation with a garden wheel hoe or cultivator. The first cultivation may

break up the ground to a depth of four to six inches, but all later cultivation should not penetrate the ground more than three inches. Flat cultivation providing a shallow surface mulch constantly is the general practice. Good cultivation will maintain a soil mulch throughout the season, thus preserving the moisture and preventing the growth of weeds.

As an experiment and for contrast, cultivate one row by ridging up the soil about the potato plants as they grow.

Combating insects and diseases. The Colorado potato beetle is pretty sure to find your potato plot and to begin his destructive work of defoliating the vines. Prepare a solution of lead arsenate, about one teaspoonful to a gallon of water, or at the rate of two pounds to fifty gallons of water, and spray over the potato plants as soon as the beetles appear. For a small area an atomizer or a sprinkling can may be used.

For the potato-leaf blight, spray with Bordeaux mixture.

Formula: 1 pound copper sulphate, 1 pound caustic lime.

Dissolve copper sulphate in hot water. Slack lime in separate vessel. When both are cool, mix and add water to make nine gallons of mixture. Add one-half ounce Paris green or one-half pound lead arsenate, and both bugs and blight are successfully combated.

Harvesting. Students will find it most practical to "lift" their crop by hand with a potato hook or fork. Dig each hill carefully, and keep the tubers in the experimental rows separate from those in the other rows so that comparisons may be made. Note the hills giving the highest yields, and save these for exhibition or for seed. Sack up the potatoes

in the usual way, weigh or measure the entire output, and store in a suitable place until they are sold or used.

Notebook record. The student's notebook should give full information concerning each of the following points:

1. Name and address of student.
2. Area of plot in square rods, number of rows, and number of hills planted.
3. Kind of soil; sand, clay, loam, etc.
4. Kind of crop grown on plot year before.
5. Kind, amount, and value of fertilizer used.
6. Preparation of soil. Date and depth of plowing.
7. Variety planted. Where seed was obtained.
8. Amount of seed used.
9. Describe treatment of tubers for scab.
10. Method of cutting seed.
11. Date and method of planting.
12. Date when vines came up and when in full bloom.
13. Dates and methods of cultivation.
14. Methods and success of combating insects and disease.
15. Date of harvesting.
16. Yield in pounds or bushels.

HOME PROJECT 11

Onion Growing

Plans. For this project the student may grow ripe onions by the two different methods: (1) by sowing the seed in the open field; (2) by planting sets. A plot of at least four square rods should be used for this project, and, of course,

the larger the plot grown the greater the possible profit.

Soil requirements. Select land that is exceedingly rich for the production of onions. Land that has been well manured and cultivated in some crop for several preceding seasons is best. In the fall heavy applications of manure should be made to the land and plowed under. Three requirements of the soil essential to profitable onion culture are: (1) richness in available plant-food; (2) good tilth due to the presence of large quantities of humus; and (3) relative freedom from weed seeds.

Time of planting. A portion of the plot should be planted with onion seed. The seed should be planted as early in the spring as the ground can be worked. An exceedingly fine seed-bed should be prepared.

The seed is drilled in rows, twelve inches apart, at the rate of four or five pounds per acre.

A second portion of the plot should be planted to onion sets, which should also be put in as early as possible. Use good-sized sets. The rows should be twelve inches apart, and the sets about three inches in the row. Plant the sets by hand, pushing them well into the soil, and be careful to get the right end up. After the sets are in, draw the soil lightly over them with a rake.

Cultivation. As soon as the plants are up, weeding and tillage should begin. Cultivate often; it is especially important that the ground should be stirred as soon as possible after each rain. The onions should be cultivated at least once each week or ten days for a period of three months. A wheel hoe is the best implement to use. Hand weeding is

nearly always necessary in onion culture. If the onions are to be thinned, this should be done before they get too large.

Marketing. If it is desired to market some of the onions as "green bunch onions," in about six weeks from planting the sets will have grown to the desired size, and the plants may be pulled and bunched for the market.

For this project it is probably better to allow the onions to ripen in the ground and market them as ripe onions.

When onions ripen properly, the necks shrivel first and the tops fall over while they are yet green. It is best to begin harvesting when the tops have fallen over and turned yellow. As the onions are pulled, the tops are twisted off and the onion bulb dropped into a basket. In commercial onion culture these onions are placed in crates and exposed to the sun for a few days, or stored in open sheds where they cure until sold on the market or placed in winter storage. The onions may cure well by being spread over the floor of a corn crib where crates and sheds are not provided.

Varieties. For this project, the Prize Taker, the Gigantic Gibraltar, and the red and white American types are good varieties to use.

Notebook record. The notebook record should be a description of how the onions were grown, with an accurate account of all expenditures and receipts.

HOME PROJECT 12

Cucumber Growing

Varieties. In selecting the varieties of cucumbers for this project, use the small sizes for pickling and the larger

varieties for slicing. For the student's home project, White Spine or Henderson's Perfected should be chosen.

Soil. Cucumbers should have a warm, moist, rich, loamy soil. Sod that has been turned over in the fall is excellent. A shovelful of well-rotted manure, thoroughly mixed with the soil at the bottom of each hill of cucumbers, should be applied. A handful of commercial fertilizer may also be added. Make the hill at least two feet in diameter, and spade the soil up to a depth of seven or eight inches. If the soil is heavy, add a shovelful or two of fibrous loam. The student should grow at least twenty-five hills for this project.

Planting. Plant the seeds out-of-doors after all danger of frost is over; usually the first or second week of May is a safe time. Plant about eight or ten seeds scattered about in the hill. The hills should be from four to six feet apart each way. When the vines begin to run, they should be thinned from four to five plants, leaving the strongest vines spaced wide in the hill.

Indoor planting. For an early start it would be a good experiment in this project for the student to grow a few hills indoors. Take sod from a very rich soil as soon as the frost is out of the ground. The pieces of sod should be from four to six inches square. Turn them upside down, and place six or eight seeds in each piece of sod, about half an inch deep. Keep these plants in a warm place and moisten regularly. As soon as they make a good start, transfer the sod with the young plants to the hills in the garden. Cucumber plants may also be started in berry boxes or flower pots.

Cultivation. Keep the surface mulched until the vines

cover the ground. Break the surface after each rain and keep out all weeds and grass. As soon as the vines begin to cover the ground, cultivation is no longer possible, but the weeds may be pulled out by hand.

Harvesting. The vines must be kept in good bearing condition by picking the cucumbers regularly. If they are left to ripen, the productiveness of the vine is weakened. As an experimental feature of the project, a few of the tips of the growing vines may be kept pinched off after the vine has reached a length of four or five feet. In this way more blossoms and fruit may be forced along the vine.

Diseases and pests. Downy mildew and wilt are diseases that sometimes attack the cucumber. Spraying with Bordeaux mixture is effective for these diseases. All vines diseased beyond control should be destroyed as far as possible. Arsenate of lead should be sprayed on the vines for the cucumber worm, and this is also effective against the striped beetle. The striped beetle is the most serious pest of the cucumber. Air-slaked lime or tobacco dust scattered about the vines often acts as a successful repellent against these pests. For melon lice, which are often serious pests of the cucumber, spray with the tobacco water or whale-oil soap. The under sides of the leaves must be reached.

Records. The student carrying on this project should keep a notebook record of every operation in the growing of this crop. This should include the date of the preparation of the ground, the planting of the seed, cultivation of the ground, the amount of cucumbers harvested, the control of the pests, and the cost and receipts for the whole project.

HOME PROJECT 13

Sweet Corn Culture

Varieties. The student who takes this project should select seed from the white variety—Early Crosby, White Cob Cory, White Evergreen, Country Gentleman—and the yellow variety, Golden Bantam. Only good seed from last year's crop should be planted.

Preparation of plot. For this project the student should have at least one-tenth acre. Sweet corn will grow on any good, rich, well-drained soil, but does best in deep, rich, sandy loam well-fertilized with barnyard manure. The manure may be put on either in the fall or spring; it must be well scattered and spaded or plowed under. A handful of wood ashes in each hill is a good fertilizer to apply. If sweet corn is planted in the home garden, the rows should be on the north side where the corn will not shade the vegetables. It is unwise to plant two types of corn, as sweet and field, or sweet and pop corn, in the same garden, as they will become crossed by the wind and insects carrying the pollen. The ground for this crop should be plowed early and deep, and the soil thoroughly packed and mulched before planting.

Planting. Sweet corn should not be planted until the soil is dry and warm. A general rule is to plant when the apple trees are in bloom. If planted in hills, the rows should be thirty inches apart, and the hills two feet apart. Drop five or six grains in a hill and cover them two inches deep. If planting in drills, drop two or three grains every six inches in the drill. As soon as the corn is well up it should be thinned

to one in a place in the drilled row, and to four plants in the hills. Suckers appearing around the roots of sweet corn should be promptly removed.

Cultivation. Make the soil loose and fine after each rain; a mulch of about two inches deep is best. The roots of corn are near the surface, and one should not hoe too deep around the hill. Liquid manure or a dressing of soda nitrate will cause a strong growth of the corn plants.

Marketing. As soon as the sweet corn is in the "roasting ear" stage, the student may begin to market his crop. Study the demands of the market and put up attractive packages to sell. Keep record of all sales.

Selecting seed. As soon as the corn begins to show silks, select about twenty stalks that showed silks first, and tie strings or tags to them above where the ear is forming. Keep all suckers off these stalks. Let the ears on these stalks go until they ripen. These ears will furnish seed for another year.

Notebook records. The student's notebook record of this project should be an account of how he grew his corn, a statement of all expenses, and the total receipts from the sale of corn, or an estimated value of the product if it was used at home instead of being sold.

HOME PROJECT 14

Growing Strawberries

Two season project. The student who chooses this project should be so situated as to be able to carry it on for two

seasons, because one season is insufficient to show results. It is one of the best projects for a young person to undertake. The strawberry is one of the most important of the small fruits.

Soil requirements. Strawberries may be grown with a fair degree of success in almost any soil, but moist, dark, sandy loam is the best. The land for this crop should be well-drained. The soil should be thoroughly prepared, plowed or spaded deep, heavily manured, and thoroughly harrowed until the surface is fine and mellow before the plants are set.

The plants. For this project the student should have at least one hundred plants to grow. Senator Dunlap, Gandy, and Aroma are some standard varieties to plant.

Setting the plants. The project should be begun early in the spring. After the ground is prepared as indicated above, lay off the land both ways in rows two feet apart. The strawberry plants should then be set at the junction of these rows. The roots of the plants should not be exposed to the sunshine. They should be set in the hole prepared for them, with the roots well spread out. Press the soil firmly about the roots with both hands, being very careful not to cover the crown. If the ground is not wet, each plant should receive about one pint of water, and loose mulch should be drawn over the moistened earth.

Cultivation. The rows should be kept clean and free from weeds at all times. When the runners begin to grow, they should be trained in circles about the plants, and not allowed to cover the space between the rows. A fine soil mulch should be maintained during the entire first summer, and during the

winter the ground and the plants should be covered with straw or marsh hay to protect the plants from freezing and thawing. Keep the plants covered until all freezing nights are over. In the spring an application of wood-ashes, if available, and nitrate of soda will be very helpful as a fertilizer.

The barrel method. As an additional feature of this project, the student may try the barrel method of growing the strawberries.

Take any strong barrel, nail on the hoops, and clinch the nails inside. Bore two or three holes in the bottom for drainage. Begin about eight inches from the bottom and bore two-inch holes, ten inches apart, around the barrel. Make a similar row of holes six or eight inches from the top, and a row of holes between the two rows just mentioned. Take land tile or a hollow wooden tile into which holes have been bored, through which the plants may be watered, and place this in the center of the barrel. Use half soil and half well-rotted manure; fill up to the first row of holes. Set the plants inside and pull the leaves out through the holes in the first row. Fill the barrel to the second row and set the plants in the same way; and so on with the third row. Always press the soil firmly before setting the plants. Fill the barrel full and set one-half dozen plants in the top. A single barrel prepared in this way and well cared for will yield an abundant supply of strawberries.

Notebook records. The student carrying out this project should record each operation, setting down the work and the performance. A record should be kept of the expense and the final harvest in connection with the strawberry crop.

HOME PROJECT 15

Growing Sweet Peas

Preparing soil and planting seed. For this project the student should plan to grow at least one hundred feet of sweet peas. These may be planted in one single row or several rows, three and one-half feet apart. Such varieties as Grandiflora and Spencer sweet peas may be secured for seed. The seeds after being soaked for twenty-four hours should be planted in a double row, about six inches apart and two inches deep. The furrow in which the double row is to be planted should be spaded up at least one foot deep. Finely ground street sweepings or well-rotted manure should be placed in the bottom of the furrow and slightly covered with rich garden loam. Then with the handle of the rake, which should be used to widen the furrows, two rows should be drilled six inches apart in the furrow. In these rows the seeds are sown, one, two, or three inches deep. They should be covered with a hoe, care being taken to remove all stones and hard earth from the surface. Firmly imbed the seeds in the soil by walking on the drills.

Early care. Sweet pea seeds may not appear to grow as soon as one would expect, but if the seed is good and the soil preparation and moisture right, they should sprout within the week. If the cutworms appear, mix about three tablespoonfuls of Paris green with a peck of bran, adding a little water to make a mash. Scatter this around the young plants. It quickly destroys the worms. The chickens must be shut up, of course, and not allowed to eat this poison or scratch out the young plants.

Cultivation. With the first appearance of weeds the hand hoe or the wheel hoe cultivator should be used between the rows. With each hoeing or cultivation the soil should be drawn up around the growing plants.

Vine support. If the student does not wish to go to the trouble and expense of stretching wire for the vines, bushy branches three or four feet long thrust firmly into holes will afford a support to the growing vines. The spring rains will cause the vines to grow very rapidly, and the peas must be hoed at frequent intervals and the soil kept carefully rounded up about the plants.

Keep blooming. If the sweet peas are planted as early as the ground and weather conditions permit, the first blossoms may be picked by the 4th of July, about three months after the planting. In order to have the best results with sweet peas they must be kept growing constantly and the blossoms must be picked regularly to produce long-stemmed flowers on the new growth. If the stems begin to shorten, bone-meal fertilizer may be hoed in around the roots with good results. A constant supply of beautiful blossoms with long stems should be produced from the beginning of the blossoming season until the frost.

During August plant lice and mildew may appear. These are combated successfully with Bordeaux mixture or nicotine and kerosene solution.

Marketing flowers. If the student wishes to sell his sweet peas, the flowers should be tied in bunches of twenty-five stems each and placed in a cellar or other cool place. Early the following morning the bunches should be sold on the

market. Florists, hotels, restaurants, tea-rooms, and private homes are often anxious for these sweet pea bunches. All the vines should be picked clean at least once every two days.

Notebook records. The record of this project should consist in keeping daily account of the date and receipts in one column, and the actual and estimated cost in another column.

Write a few paragraphs telling how you grew your sweet peas.

HOME PROJECT 16

Beautifying Home Grounds

The first thing to do in preparation for this project is to measure the home grounds and draw a map to a scale in the agricultural notebook. A good scale would be one-sixteenth of an inch to the foot.

Locate accurately on the map the lawn, houses, trees, shrubs, and other objects as they are at the beginning of the project. Indicate houses by squares; lawns, by words neatly printed; trees, by circles; shrubs, by stars; and other important objects by figures explained in a key on another page. Refer also to each tree and group of shrubs or flowers by number explained in a key. For example, the figure (1) by a circle on the map may indicate maple tree, and should be so explained in the key.

Later, as the work of the season proceeds, mark on the map the plantings and changes you make.

Principles to observe in beautifying the home grounds,

the A, B, C's of landscape gardening. Copy the following principles into your notebook and learn them well:

1. An open lawn of greensward should be the main feature of the home grounds. An especially beautiful tree or clump of plants on the open lawn is permissible.

2. Borders of shrubs in masses, and a backgroun of trees and shrubs in clumps and groups, should furnish the frame for the picture of the home grounds.

3. Where the place is large enough, walks should curve, and at the corners and ground line of the house curves may be made by plantings of shrubs and herbaceous plants.

Beginning the work. Study the map of your home grounds as they are, and determine whether it is practicable or desirable to remove any plant or object that stands in violation of the A, B, C principles given above.

Improving the lawn. It is not the purpose of this project to suggest any elaborate undertaking such as grading, draining, plowing, and remaking old lawns; however, some of these things might be done by high-school boys.

1. If the project is begun in the fall, a top-dressing of stable manure applied in early winter to be removed in the spring would greatly benefit the lawn. This plan might, however, be objectionable in some cases.

2. In the spring the lawn will be benefited by the application of about three hundred pounds of ground bone to the acre. The same amount of nitrate of soda will reinvigorate the grass.

3. If there are barren or poorly sodded spots on the lawn, the ground may be worked up and re-seeded. Use a mixture

of blue-grass, red-top, and white clover seed, at the rate of 20 pounds blue-grass, 20 pounds red-top, and 5 pounds white clover seed to the acre; or some good lawn mixture sold on the markets may be more easily obtained. Henderson's Shady Nook grass is excellent to grow under trees and in shady nooks. The seed should be sown when the land is moist and the weather cool.

Planting bulbs. If the project is begun in autumn, the student should send to some good nursery or purchase from a local house a few such bulbs as hyacinth, tulip, daffodils, etc., to set in the ground in November for early spring blossoms. Prepare a bed in which to plant the bulbs in a rich, well drained place along the border of some shrubs, a fence, or near the house. Place a handful of gravel beneath each bulb, cover it with three to four inches of soil, and mulch the ground well with strawy manure. Remove the mulch in the spring and the bulbs will do the rest.

In early spring such bulbs as canna, calladium, lily, gladiolus, and dahlia may be set as described above. The student should get a few bulbs of this kind to use in the early work on the home grounds.

Seeding for herbaceous plants. The following seed should be obtained and planted as described below:

1. **Castor beans.** Send for a dozen or more castor beans. Get the seeds as early as possible, and plant them in a box or pot indoors in order to have early plants to transplant as soon as the ground warms in the spring, and the danger of frost is past. Transplant the bean plants to rich loam soil when they have four or six leaves. Place them in groups of

three or four, five or six feet apart, at the corner of the house, at the back of the lawn, or to screen objectionable views.

2. **Cosmos.** Prepare a long border bed against a fence, or to screen the garden or some ugly object from view, and sow the cosmos seeds rather thickly.

3. **Nasturtiums.** Sow early a bed of nasturtiums along the ground line of the house or porch, and provide supports for them to vine upon.

4. **Dwarf sunflowers.** A row of these plants may be grown about the poultry yards and garden, or they may be grown in a mass to hide some unsightly object.

5. **Sweet peas.** A border bed of sweet peas is always delightful, either at the house or in front of a taller mass of shrubs or plants.

6. Any other annual or perennial which the student desires to grow may be used in the project.

Vines. At least one vine should be planted at the porch to aid in the work of beautifying the home grounds. Get one or two moon-vine plants and set in rich ground at the porch. The common wild woodbine is an excellent one to use.

Shrubs and trees. It may not be practical in many home grounds for the student to attempt any planting of shrubs or trees, but, if at all possible, at least one tree should be planted and a few shrubs set out in this project.

Get from the woods any common, native, small tree and transplant to the border of the yard. Observe carefully all the rules of transplanting. Dogwood, redbud, maple, ash, or

even oak may be successfully transplanted and would add much to the home grounds.

Such wild shrubs as sumac, elder, hazel, and the prairie rose are to be commended for home grounds. The student should transplant at least one shrub in this project. The Spirea Van Houttei, the hydrangeas, and the barberries are popular ornamental shrubs.

Summer care. Keep the lawn well clipped, and water if the weather be extremely dry. Keep weeds out of all flower beds and the soil loosely mulched. Keep the yard neat and clean from all trash and clutter.

Notebook records. In addition to the map of the yard as required at the beginning of the project, the student should keep a diary record of all operations on the home ground.

HOME PROJECT 17

Care of Fruit Trees

Select at least six fruit trees of bearing age to use in this project. Make the following notes and records in the agricultural notebook:

1. Trees' name, variety, age, location, trees near, general condition, past record of the trees as to fruitfulness.

2. Condition of soil, cultivated or in sod, clay, loam or sandy loam, drainage, fertilizers used in past.

Soil improvement. If water stands about the trees at any season for any length of time, drainage should be given. (Use tile drains.)

If the soil is sour, limestone should be used. To ascertain whether the soil is acid, take a ball of moist soil from beneath the trees and press it about a strip of blue litmus paper. If after ten or fifteen minutes the paper turns red, it is an indication that lime is needed. Spread about two bushels of slaked lime on the ground under each tree. Work it into the ground. This may be done at any time.

If the ground about the trees has not been cultivated, good results may be obtained by the use of dynamite. About one-fourth of a stick placed about two feet deep in the ground on each of the four sides of the tree will loosen up the ground and revive the tree. The dynamite should be used only by an experienced man.

If practicable, the soil about the trees should be spaded or plowed up as early in the spring as possible. About a half ton of stable manure should be spread about under each tree, when only a few trees are to be cared for. Providing a mulch of strawy manure under each tree would be the most practical way to treat the soil in this project.

Pruning. At any time before the buds open in the spring the fruit trees should be pruned. The older apple, pear, or peach trees will probably need severe pruning. This will consist mainly in lowering the crown, cutting out dead and dying branches, and all limbs that run criss-cross and rub against other branches. The following principles should govern the work of pruning:

1. Be able to give a reason for every cut made.
2. Never leave stubs—always prune immediately above a living branch which is to be left.

3. Make the cut smooth and close to the branch or trunk.

4. Paint over the cut surface with white or red lead, or with creosote solution.

Spraying. In this project four sprayings are recommended:

1. Spray the fruit trees before the buds open in the spring with a concentrated lime-sulphur solution, one gallon to ten or twelve of water. This spraying cleans the trees of scale and of many fungous diseases.

2. Spray again within a week after blossoms have fallen. Use this time a solution composed of one and one-fourth gallons lime-sulphur, two and one-half pounds lead arsenate in fifty gallons of water. This spraying controls the codling moth, the leaf-eating insects, and such diseases as the apple scab, rust, brown rots, etc.

3. Spray the third time, using the same material, about three weeks later. This spraying is effective against the codling moths as they are seeking the apple, other chewing insects, and the diseases mentioned above.

4. The fourth spraying should be done about the last of July. Use lead arsenate, Bordeaux mixture (4 pounds copper-sulphate, 4 pounds lime) with fifty gallons of water. This spraying is to combat the second brood of codling moth, leaf-eating insects, and plant diseases, especially the bitter rot.

5. Use a good barrel spray pump and thoroughly spray each tree.

Grafting. In connection with this project the student should do some top grafting on his fruit trees. This work should be done in the spring before the buds open. Select a

good, healthy branch from three-fourths inch to two inches in diameter in the top of the tree upon which the graft is to be made. Make a smooth, square cut for a stock upon which the scion is to be inserted. Select two scions for each graft. These scions should be from bearing trees of the variety desired and from last year's growth. Cut each scion to three buds. Make a cleft in the stock, and insert the scion according to directions given in the chapter on orcharding. The teacher should demonstrate this work. Grafting wax should be placed over all exposed cut surfaces.

Setting out a young orchard. The student may choose this phase of the orchard project instead of one of the preceding if he wishes.

1. Select at least one acre, preferably on rolling land, to use in this project. The soil should be fertile and well drained. Plow the ground deep and prepare it for planting in the fall. The trees may be planted either in October and November or in April.

2. Send to a reliable nursery for the stock. Use apple trees in this project. To plant the acre will require about thirty-six trees. Select varieties to produce apples for summer and winter use according to the tastes of the family.

3. Lay out the acre orchard plot in rows so that the trees will be either in squares or in triangles, 36 feet apart. The triangular arrangement is preferable, since more trees may be planted to the acre.

4. Prepare ample space in the ground for the roots of the young trees, and firm the soil well around the roots. Prune the roots to eight or ten inches in length before planting.

Leave a loose soil mulch over the surface of the ground about the trees.

5. If the trees are planted in the fall, some mechanical protection should be made against the rabbits. A roll of common window screen about the trunks affords good protection. Wrappings of burlap, cloth, coarse paper, or other substances will serve to protect the young tree trunks.

6. In the spring before the buds open the young trees should be pruned. Leave the lowest branch from 24 to 30 inches from the ground; cut back all the branches to 8 or 10 buds. Prevent forking branches, and leave a central branch to rise above the others.

7. During the spring months and as late as the middle of July cultivate the young orchard, keeping down all grass and weeds and providing a soil mulch. After the last cultivation sow the orchard to cow-peas, soy beans, vetch, or clover to provide a winter mulch and to enrich the orchard soil.

Notebook records. Keep a map of the orchard showing location and names of varieties planted. Keep a cost account of all expenses incurred in the project, including cost of material and labor. Estimate the profit or loss. Keep a diary of operations performed in the orchard from the beginning to the sowing of a cover crop in July.

HOME PROJECT 18

Planting a Catalpa Grove

Select a plot of fertile, well-drained ground from one-tenth to one acre in size to be used for growing catalpa.

Preparation of ground. The little trees may be planted

in the fall or spring. In either case plow the ground deep and harrow it down well. Lay the ground off in furrows six feet apart each way and set the trees where the furrows cross.

Procuring the trees. Send to a reliable nursery for *catalpa speciosa.* Insist on the *speciosa.* About 1,000 trees may be planted on an acre. These will cost about $5 a thousand for seedlings. The Ohio Valley Nursery Company, Lake, Indiana; the Little Tree Farms, Farmington, Mass.; Storrs, Harrison & Company, Painesville, Ohio, are reliable dealers in catalpa.

When the little trees arrive, plant them carefully on the ground prepared. Thrust the spade into the ground at the intersection of the furrows, pry the soil back, and insert the roots of the little tree in place. Firm the earth well about the roots.

Cultivation. During the first three or four seasons after planting, the little trees should be cultivated during May, June, and part of July to keep the weeds down and to hasten the growth. When the cultivation ceases in July it is well to sow a crop of cow-peas or soy beans among the trees to provide a winter mulch and a green manure to be plowed under in cultivation the next season.

During the growing season all side shoots and forking branches appearing on the young trees should be broken off. This will hasten the growth of the central stem and make clean, straight boles in the trees.

Notebook record. The student should record all operations in his agricultural notebook.

HOME PROJECT 19

Growing Sudan Grass

With the growing popularity of this new forage crop, it is well for the student to undertake as a home project the growth of at least one-tenth of an acre of sudan grass.

The plant. It is a tall annual grass growing from a height of six to eight feet. The stems are fine and leafy. They stool out to as many as twenty to one hundred stalks from a single root. The sudan grass lacks root stalk, and can never become a troublesome weed.

Seeding. In the spring, at about the time the corn is planted, the same ground and the same seed-bed preparation required for corn may be used for the sudan grass. Sudan grass may be sown in midsummer after oats, wheat, or rye. Sow one-half of the area broadcast, and the other half drilled in rows thirty-six inches apart. It would be well to have about one pound of seed for this project. The drilled portion of the plot should be cultivated to keep down the weeds during its early growth.

Cutting. Sudan grass is a rapid grower, and may be cut, under favorable climatic conditions, twice during the season. It is best cut when in full bloom, and early cutting is advisable when more cuttings are expected. The grass can be cut with a mower or a binder, and the hay cures readily in bundles.

The second crop, if allowed to mature, may yield an excellent crop of seed, and, since the price of seed varies from fifty cents to one dollar per pound, the production of sudan

grass seed is a profitable undertaking. Seed grown for commercial purposes should be grown on land not infected with Johnson grass. Johnson grass is abundant, and grass seed for sale should be raised in cultivated rows, taking care to hoe out any Johnson grass that may appear.

Notebook record. The student who carries out this project should keep record of the following points:

The amount of land utilized.

The time and method of preparation of seed-bed.

The method and amount of seeding.

The favorableness of season.

The time from planting to blossoming.

The time of cutting.

The difference in growth observed between the plot sown broadcast and the one drilled.

The success of the second crop.

The amount of hay and seed produced.

The total cost of the project, item by item.

The total value of the crop.

The profit or loss sustained.

HOME PROJECT 20

Making a Concrete Walk

The project. For this project the student should construct, according to the directions given below, a strip of concrete walk either at the school or at home. The time of the year and the type of the soil will very largely determine the method of laying the foundation for the walk.

The foundation. A good foundation is an important essential in the construction of a concrete sidewalk. As a rule under normal conditions of soil and climate the foundation should be from 6 inches to 10 inches thick. For this project plan to build a walk consisting of a 4-inch layer of concrete resting upon a 6-inch foundation, with the surface of the walk 2 inches above the level of the ground. Excavate to a depth of 8 inches. Fill in 6 inches of cinders, gravel, or crushed rock, tamping it down thoroughly as it is being filled. It would be a good plan to wet down the foundation as it is being tamped. Allow for drainage by extending the excavation 2 inches or 3 inches on each side of the walk. On each side on top of the foundation place 2x4-inch straight stringers, and drive stakes down outside of stringers to hold them in place.

Making the concrete. Use a mixture of 1:2:4 and mix with sufficient water to make the concrete moderately wet. Tamp the concrete until the water appears on the surface. Spread a finishing coat about 1 inch thick made of a mixture of 1:1. To prevent the cement from chipping off, coat the cement below the surface layer with pure cement before applying the finishing coat. Level off the finishing coat, smooth it with a float, and groove with a jointer. Keep the walk covered and wet for two or three days after being laid to allow it to dry uniformly. Wet sawdust or wet sand is a good covering, or strips of canvas held in place by weights may be used.

Notebook record. For the notebook record of this project draw a sketch of the sidewalk, showing the depth, length,

and various layers used. (Write a paragraph describing the method used.)

Itemize the total expenses of every article used, and the cost of the labor employed at 50 cents an hour.

HOME PROJECT 21

Making a Farm Gate

For this project the following material is necessary:

6 boards pine 1"x6"x12'
3 boards pine 1"x6"x5'
1 board pine 1"x6"x9'
1 pc. hard wood 1"x3"x4' 6"
1 pc. hickory 1"x1"x3' 3"
1 lb. 10d. nails.
1 pair hinges
2 doz. screws 2", No. 10, F. H. B.

TOOLS

Steel square	Hammer
Saw	Screwdriver

Sawing boards to length. The gate is to be 12 feet long; measure up and saw off six boards of that length. The three uprights are to be 5 feet long and the brace is to be 9 feet long. The brace should not be beveled until after the gate has been assembled.

Nailing gate together. Lay five of the 12-foot boards 6 inches apart on the floor. Lay the sixth board against the edge of the fifth. Lay one upright across each end, and drive one nail through the uprights into the end of each board properly spaced, with the end of the boards flush with the edge of the upright. An easy and satisfactory method of spacing the boards is to take a block that has been

cut from one of the boards and place it between the last board nailed and the next one to be nailed. When you have put one nail in each board, then square up the gate with the steel square and fasten in place by driving a second nail in each board. Four feet from one end, square a line across the top and bottom board. This line locates the third cross-piece, which should be nailed in place.

Cutting bevel on brace. To cut the bevel on the ends of the brace, lay it on the gate so that the ends are flush with the top of the upright at the end and with the bottom of the next upright. Place the steel square so that its edge is flush with the edge of the upright, line across the bevel, and saw along this line. Repeat at the other end.*

Notebook record. Draw an accurate design of the gate constructed. Give cost of all material and labor used in the construction of the gate.

HOME PROJECT 22

The Young Farmer's Business Office

Farming a business. Farming is a real business, a big business, a difficult business, and a good business. Every boy who undertakes a farm project is making a good start as a business man. He should have an office of his own. This project outlines a scheme by which an office may be fitted out for a boy, and everyone who carries on a home project should have a farm office of his own.

*Courtesy of American Book Company, from "Farm Shop Work," by Brace and Mayne.

The office. Find some place about your home that you can call your office. It may be in your bedroom, in some small room, in the corner of a large one, in some building near the home, or in a place which you can fix up. Make this a place to keep most of your belongings, and to carry on your business affairs even if they are small. Call this your business office.

The equipment. In this office have a desk with drawers, pigeon-holes, and shelves for keeping your account books, bank book, check book, pens, pencils, ink, paper, envelopes, bulletins, clippings, crop records, etc. If you cannot buy a desk for your office, make one. Instructions for making a desk are given further on. Have some book shelves, a calendar, and some pictures on the walls of your office to make it look business-like and attractive.

Bookkeeping and records. Have a good, permanent, well-bound account book or ledger in which to keep an account of all your business and the agricultural projects you carry on.

In the first part of the book you should make a list of what you own. This is called an inventory. You might start it this way:

INVENTORY OF WHAT I OWN.

Date..................1916.

Article	Value
1 Knife	$0.35
2 Books	1.25
1 Pig	4.75
1 Office desk	5.00
Money in bank	7.50

On separate pages keep accounts of things you are doing for a business. The home project you are carrying on in connection with your school agriculture or club work should be fully recorded in this book, in addition to such reports as are required for the agriculture class or club.

BUSINESS ACCOUNTS

Expenses—Corn Project

Rent of land	$5.00
Preparation of seed-bed	3.60
Cost of seed	.25
Cost of fertilizer	1.00
Cost of cultivation	5.50
Cost of harvesting	5.00
Total	$20.35

Receipts

Total number bushels	$109.37
Total value of crop	87.50
Less expenses	20.35
Net profit	$67.15

How to make the desk. Probably you can find enough lumber around home to make a desk. Only the ordinary farm tools are necessary. For about $1 you can get enough lumber at the mills. Have the lumber sawed to make a desk top 36 inches high, 10 inches deep, and as wide as necessary to fit properly your table top. Fasten together the bottom and two upright ends, and make them tight and strong by fastening the first cross piece to each upright so that the bottom shelf will be 10 inches high. It would be best to have

grooves for all partitions made at the mill where you get the lumber, unless this work can be done at home or in the school. Slide in the two bottom partitions. Put in the second horizontal piece five inches above the first, and place the partitions for the pigeon-holes. Fasten in the top shelf nine or ten inches above the second shelf. Go over all the joints and tighten them up. Use finishing nails and drive them straight. Plane any joints that are uneven and rough.

Place the structure on your table in your room. Equip your home-made desk with pencils, pens, and such other supplies as you need to make your farm office ready for use.*

HOME PROJECT 23

Farm and Home Survey

The student choosing this project should carefully copy this outline in his notebook and supply all required information regarding his home and community.

Location: State, county, township, section, school district.

1. Owner of the farm.
2. Number of acres in farm.
3. Operated by owners or tenant.
4. Number of years on this farm.
5. Number of years in the community.
6. The village center. Population.
7. Names of persons in the home. Birthplace. Age.
8. Hired help employed.
9. Members of family attending school. Kind of school. Are the parents willing to have their children study agriculture, domestic science, etc., in school?
10. Church affiliations.
11. Church attendance. Percentage of days for each member.

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*Courtesy of William Kendrick, Morgantown, W. Va.

12. Sunday school attendance. Percentage of days for each member.
13. Societies or associations represented.
14. Clubs or lodges.
15. Does family make use of a public library?
16. Are agricultural bulletins read in the home?
17. List of newspapers in the home.
18. List of magazines in the home.
19. List of community events attended or shared in.
20. Members of family who are leaders or officers in any rural organization or institution.
21. Natural resources of the farm.
    Animals: Number and breed of horses, cattle, swine, sheep, poultry.
    Fruit: Size, age, and condition of the orchard.
    Size of vegetable garden.
    Farm crops: Number of acres of corn, wheat, oats, timothy, clover. Yield of corn, wheat, oats, timothy, clover. Number of acres of alfalfa; yield. Number of acres in pasture. Number of acres in wood lot; second growth or planted.
22. Number of acres of waste land. Why waste?
23. Farm equipment, buildings, implements (sheltered?), conveyances.
24. Modern conveniences in the farm home.
25. Size of yard. What measures for beautifying yard and farm?
26. Health conditions: Deaths in the family; causes. What diseases have been in the home during the past three years? What is done to combat the house fly? What is the source of the water supply? How is waste and sewage disposed of? Are the living and sleeping rooms well ventilated? Are there any superstitions about health?

Community Census

(Answer as fully as possible.)

I. Natural Resources:

1. General topography and elevation.
2. Is there a soil survey of your community? If so, what is the soil type? The limiting soil elements?

3. What mineral resources has the community?
4. What farm products are sold out of the community?
5. What farm products are bought by the community?
6. What are the manufacturing interests of the community?
7. Is the community conserving its natural resources?

II. Human Resources:

1. The general moral and intellectual tone of the community.
2. Are there any vicious forces in the community?
3. Who are the strong leaders in the community life?
4. Has the community ever sent out any men or women who have become famous in the world's work?
5. Has the community any memories or traditions which should be respected by coming generations?
6. Are there any latent human resources unappreciated and undeveloped?

III. Economic Activities and Interests:

1. The leading industries.
2. Means of transportation.
3. Means of communication.
4. Condition of roads.
5. Average land values.
6. Is there any cooperative buying and selling in the neighborhood? Do you have good markets?
7. Is there a drift from the country to the city in your community? If so, give the reasons for moving from country to city.

IV. Community Health:

1. General standard of health in the community.
2. Are the health officers intelligent and alert in doing their duty?
3. Have there been any serious epidemics in recent years?
4. What influences are at work to improve health and sanitary conditions?

V. Local History:

1. Was the region occupied by Indians before the white men came? What Indian history is known?
2. Are there any Indian relics or indications of former occupancy?

3. Who was the first white man in the community? What is known of him?
4. What was the first school and church in the community?
5. Are there any pioneers left to tell the early history?
6. Has the community ever suffered great disaster?
7. Did war ever touch the community?
8. Have soldiers ever gone from the community to war?
9. Has the community ever taken part in any events noted in history?
10. Are there any great public works near?
11. Are there any historic sites near?
12. What has hindered or helped most in the community development?
13. New England or southern ancestry?

VI. Political Life:

1. What political parties in the community?
2. Which party predominates?
3. Are there many independent voters?
4. Attitude of people toward payment of taxes? Do the farmers feel over-burdened?
5. What are the various tax rates for various purposes? State, county, town, road, special road, school.
6. What is the assessed value of the property of the district?
7. Do the people know how the public money is being used?
8. Is there any feeling of class distinction in the community?
9. Is there a public opinion in the community favoring the enforcement of law?
10. Is anything being done for the civic education of the community?

VII. The Country Beautiful:

1. What natural objects of beauty in the community?
2. Is the community doing anything to protect and preserve the natural beauty?
3. What influences and factors, if any, are working to destroy the natural beauty?
4. What beautiful buildings are in the community?
5. Are the streets of the town and country beautiful?
6. Are there any parks that have been beautified?

7. What influences are working to add beauty to the community?

VIII. General Social Life:

1. What are the objects that draw people together in your community?
2. Are there any social gatherings which include the whole community?
3. Forms of commercialized social gatherings.
4. Are there any influences which interfere with the neighborliness of the community?
5. Special efforts made to provide social life for the young people.
6. Is there any home or community interest in the proper association of the young people with each other, or do the adults hold aloof and let the young folks go their way?
7. Is the social life of the community organized around any social center?
8. Is there a federation of community organizations?

IX. Recreations, Play, and Amusements:

1. List the recreational activities of your community. In-door. Out-door.
2. What institutions are actively interested in the recreations of the people?
3. Do the homes provide adequate recreation?
4. What organizations are making provisions for the recreational activities?
5. What festivals, pageants, celebrations, etc., are held?
6. Is the play life in the community a constructive element?

X. Religious Life:

1. Are the churches strengthening the religious life of the community?
2. How many churches and for what population?
3. How long is the average pastorate? Does the minister receive a living salary? Does he live in the community?
4. Do the ministers visit the homes, and are they conversant with the occupations of their members?
5. Are the churches strong in their leadership for a progressive country life?

6. Are there any organizations for young men and young women connected with the church? Give name and number of members in each organization.

7. Are there meetings, lectures, Sunday schools, or chautauquas for general religious education?

XI. Intellectual Life:

1. Is there a community interest in maintaining good schools?

2. What organizations in the community outside of the school contribute to the intellectual life?

3. Kind of grade school in the community? One teacher or consolidated?

4. Is a high school within reach of every boy and girl when he or she is ready for it?

5. Is vocational work taught in the schools? State what is taught if vocational work is offered.

6. Is the school attempting to reach out and contribute to the education of the whole community? In what ways?

APPENDIX

AGRICULTURAL CLUBS IN HIGH SCHOOLS

With the growth and development of agricultural departments in our high schools, there ought to be an increasing number of boys and girls who are interested permanently in country life. In many of the high schools of the state a large percentage of the students are from the country. Many of the country boys and girls, whether studying agriculture or not, are proud to be country born and bred, and would be glad to form an organization having the strong tie of country life interests as the fraternal bond of such a group.

These clubs may be considered as having rather free filial relationships with the same organizations in the state universities. They will at any rate train up good members for the collegiate organizations, should the student go to the university, or prepare good leaders for such organizations, should the student return to a country life vocation. There is a slight possibility that the Collegiate Clubs might be able to send delegates to those high schools wishing to form such an organization.

The following constitution is recommended in order to have uniformity in these clubs:

CONSTITUTION AND BY-LAWS OF THE HIGH-SCHOOL AGRICULTURAL AND COUNTRY LIFE CLUB

Article 1. Name

Section 1. The name of this organization shall be ....High-School Agricultural and Country Life Club.

Article 2. Objects

Section 1. The object of this organization shall be: To encourage the study of agriculture and household science in the school

and home, and to cultivate among the boys and girls of the high school a love for the open country, the farm life, and the country home.

Section 2. To promote contests in plant growing, animal raising, and the holding of exhibitions of farm products grown or produced by the members of the club.

Section 3. To train active and efficient leaders among young men and women for rural life progress.

Section 4. To furnish opportunity through organization for social activities, such as literary programs, social gatherings, out-door picnics, play festivals, etc.

Article 3. Members

Section 1. All the boys and girls of the high school who are sincerely interested in agriculture and country life are eligible for active membership.

Section 2. Pupils in the seventh and eighth grades and young people not in school may be elected as associate members with all privileges of the club except holding office or voting. New members are elected by a majority vote of the club at the next meeting following the presentation of their names.

Article 4. Officers

Section 1. The officers of the High-School Agricultural and Country Life Club shall be president, vice-president, secretary, treasurer, and program committeeman.

Section 2. It shall be the duty of the president to preside at all meetings, preserve order, and demand obedience to all rules. His emblem is a red ribbon worn on the lapel of his coat. The vice-president shall assist the president in all his duties, and preside in his absence. His emblem is a blue ribbon. The program committeeman shall arrange the literary program for all regular meetings, calling to his assistance any two members as program committee if he wishes, and shall submit the program to the principal of the school for his approval. His emblem is a green ribbon. The secretary shall keep the minutes of all meetings, receive fees and dues of all members, pay the same to the treasurer, take and keep his receipts thereof. His emblem is a white ribbon. The treasurer shall take charge of and keep all money of the club, and pay out the same only upon orders signed by the president and secretary. His emblem is a yellow ribbon.

Section 3. The officers shall be elected by the club for one year at the last regular meeting in May.

Article 5. Meetings

Section 1. The Agricultural and Country Life Club shall meet every two or four weeks, at the place and time designated by the club, upon the approval of the high-school principal.

Section 2. The order of business at the regular meetings shall be as follows:

1. Call to order by President.
2. Roll-call.
3. Reading of minutes.
4. Literary program.
5. Reports of committees.
6. Proposals for membership.
7. Voting on new members.
8. General business.
9. Adjournment.

Article 6

Section 1. The regular program shall consist of music, recitations, readings, essays, orations, debates, and extemporaneous talks, etc. The public should be invited to these meeting.

Section 2. The club shall co-operate with all local and county agricultural movements, contests, etc., such as corn growing, garden work, and household science clubs.

Section 3. An annual exhibit of farm products is recommended. The club should provide a program, invite the patrons of the school, and through the principal make provisions for ribbons or prizes for the best exhibits.

Section 4. The club shall arrange an annual picnic or play festival some time during the latter part of the school year. Programs of music, declamations, athletic events, refreshments, etc. shall be provided by the club.

Article 7

Section 1. The letter (C) shall be adopted as the badge and emblem of the Agricultural and Country Life Club, and may be worn by all members.

Section 2. Any member of the club who shall have distinguished himself in any one or more agricultural or country life achieve-

ments, such as winning first or second honors in state or county plant or animal growing contests; winning honors in household science contests; growing as much as an acre of any standard farm crop and producing above the average in yield for that crop in the state; owning and caring for some pure-bred domestic animal according to approved methods; any other country life achievement showing superior ability, shall, upon the recommendation of the principal of the school, have conferred upon him at the agricultural short course at the state university, by the presidents of the Agricultural Club and the Collegiate Country Life Club of the state the honorary title of "Master Countryman."

REFERENCES

Text-Books

Principles and Practices of Poultry Culture—Robinson.
Profitable Poultry Keeping—Davis.
Animal Husbandry for Schools—Harper.
Beginnings in Animal Husbandry—Plumb.
Field Crops Production—Livingston.
Field Crops—Wilson and Warburton.
Productive Orcharding—Sears.
Productive Vegetable Gardening—Lloyd.
Manual of Gardening—Bailey.
Orchard and Garden—Douglas.
Farm Crops and Soils—Mosier.

Bulletins and Circulars

Feeding Dairy Cattle—Circular 152, Ill. Exp. St.
Feeding the Pig—Circular 133, Ill. Exp. St.
Farmers Bulletin No. 409, U. S. Dept. of Agriculture.
Corn Day Annual—Illinois State Department of Public Instruction.
Alfalfa—Circular 12, Illinois Exp. St.
The Home Vegetable Garden—Circular 154, Ill. Exp. St.
Farmers' Bulletin, No. 245, U. S. Dept. of Agr.
Potato Primer—Mass. Agr. College Circular.
Onion Culture—Cir. 173, Ill. Exp. St.
Farm Craft Lessons—U. S. Boys Working Reserve.

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